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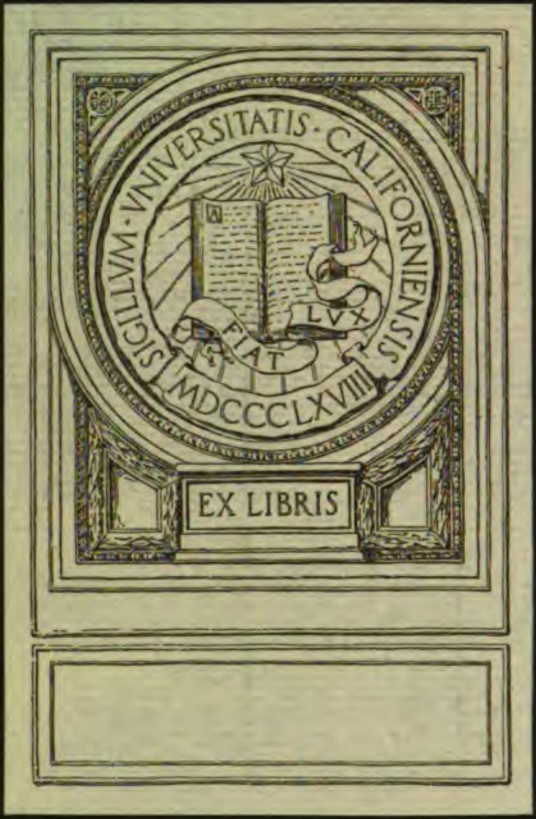

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PHYSICAL GEOGRAPHY MANUAL

A LOOSE LEAF SYSTEM

of

FIFTY SIMPLE LABORATORY EXERCISES

for

HIGH SCHOOLS AND ACADEMIES

by

N. A. BENGTSON, A. M.
Assistant Professor of Geography and Economic Geology
THE UNIVERSITY OF NEBRASKA

W. M. WELCH MFG. COMPANY
Department of Scientific Apparatus
100 LAKE STREET ∴ ∴ CHICAGO

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SUGGESTIONS TO TEACHERS

Laboratory and field work is now universally recognized as essential in a physical geography course. This recognition has brought with it a need for simple exercises that can be performed by young high school pupils. In many cases inadequate room, lack of apparatus, and untrained teachers make the problem of presenting laboratory work difficult. These exercises are presented to meet this need and assist in overcoming the difficulty. They have been carefully tried under nearly all conditions and are the result of co-operative work done by over thirty high school teachers and the author during the past three years.

NUMBER OF EXERCISES TO BE STUDIED

In a one-semester course at least twenty-five exercises should be performed. Twenty is held as the minimum requirement where this work is presented as a college entrance credit. The exercises recommended are chosen from four main divisions of the subject—General Earth Relations, 3; Minerals and Rocks, 6; Land Forms, 8; Atmosphere, 8. It is advised that this distribution of the exercises be followed in the main, altho local interests may suggest the wisdom of some changes. For teachers who prefer a ready made list the following is offered:

General Earth Relations,—Exercises I, IV, and V.

Minerals and Rocks,—Exercises VII, VIII, IX, XI, XII, and XIV.

Land forms,—Exercises XV, XVII, XVIII, XIX, XXII, XXIV, XXVI, and XXVII.

Atmosphere—Exercises XXVIII, XXX, XXXI, XXXII, XXXVI, XXXIX, XLIV, XLV.

ORDER OF EXERCISES

The order in which these topics are taken up should follow that of the text used. If the text takes up the study of the Atmosphere preceding that of Land Forms the laboratory studies should conform to that arrangement. It is recommended that in all cases where this subject is the first laboratory science in the high school course, the work should begin with Exercise 1. This exercise is so simple that all pupils can readily master it. Thus the "scare" of laboratory work is overcome. It also emphasizes accuracy, and thus teaches the necessity of careful work. The work in Minerals and Rocks should always precede the topographic map studies of Land Forms. Minerals and rocks should be viewed as the content of the land, and the source of the soil. It is essential to know something of the content of the land in order to appreciate its topography.

APPARATUS AND SUPPLIES

No exercises herein given demand expensive apparatus and supplies. In most cases much of the material can be furnished at home. The mineral specimens should be studied but not destroyed. Where properly supervised a complete set of student's specimens should last at least four years, and then only part of them need be replenished. A good plan is to furnish each pupil a small specimen of each mineral, and to have a set of larger specimens for reference and comparison. Never let several pupils work together when performing the exercises on minerals and rocks and the land forms. The materials are inexpensive. Be sure to have enough to go around.

Some of the studies on "Atmosphere" can well be carried out by the pupils working in groups of from two to five. In some cases it may be advisable for the teacher to perform the experiments, and let the pupils take notes and record observations.

TIME REQUIRED

Most of these experiments are brief. If everything is in readiness, the work can usually be done by average students in forty-five minutes. This of course does not allow time for setting out or putting away material or for making carefully written reports. Wherever possible double class periods should be used for one laboratory period. But where such is impossible very efficient work can be done in single class periods. In fact where no extra time whatever can be arranged for the laboratory work, it is recommended that the class work be given but three days in the week and the other two days be devoted to the laboratory studies. The text can be used more efficiently this way, even with less time given to it, because the work in the laboratory illuminates it and makes it real.

LABORATORY REPORTS

The reports of the exercises should always be written carefully in ink. Where double laboratory periods are given this should be done in the laboratory at the time the work is done. Where only single periods are used, pupils may take notes on extra paper and prepare the final reports in some study hour before the next day. It is advisable to use part of the next period, either class or laboratory hour, for a general review of results accomplished. The teacher should carefully review the notebooks at least once a month, preferably calling in a few at a time so that pupils will feel that their reports may be called for at any time.

LABORATORY ROOM

The time is coming when specially arranged laboratories will be available. Generally such is not now the case. This was kept in mind in writing these exercises. The work can be done efficiently in any room equipped with tables or desks. Physics or Chemistry laboratories or even ordinary class rooms with individual desks will serve very well.

FIELD WORK

Classes should be led to describe and interpret the physical features of the local environment. Suggestive outlines are herewith provided, but the teacher must modify and adapt to meet the needs of her particular locality. Field work offers the richest opportunity for rounding out the course, and every class should take full advantage of studying all available features.

SUMMARY

Every pupil in a physical geography course should gain the power,—

To recognize the common minerals and rocks and to know something of their properties and uses.

To read and readily interpret topographic maps.

To appreciate the development of the surface features of the land.

To understand the fundamentals of weather phenomena, and to intelligently interpret the weather map.

To look upon the earth as a living thing, a subject of Nature's great laws.

ACKNOWLEDGEMENTS

Whatever of merit there is in these exercises should be attributed largely to those who have so ably assisted by their criticism and co-operation. Those to whom the author feels especially indebted are Professor G. E. Condra of the University of Nebraska, Miss Donee Griffith of the Teachers' College, University of Nebraska, Professor E. E. Lackey of the Wayne State Normal School, Miss Lulu Beekley of the York High School, Supt. B. E. Dill of Wilber, and Supt. W. T. Davis of McCook, Nebraska.

APPARATUS AND SUPPLIES
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PHYSICAL GEOGRAPHY MANUAL
By
PROFESSOR N. A. BENGSTON

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7	12	5218	Glass Plates, 6x6 inches	.84
	60	5620	Test Tubes, 6x⅝ inches	1 25
	6	4652	Reagent Bottles, 4 oz., filled with Hydrochloric (Muriatic) Acid	1.20
	1 lb.		Rose Quartz	.15
	1 "		Milky Quartz	.10
	1 "		Quartz Crystal	.35
	1 "		Flint	.10
	1 "		Agate	.40
	1 "		Smoky Quartz	.15
8	1 "		Orthoclase	.10
	1 "		Mica-Muscovite	.15
	1 "		Mica-Boitite	.35
	1 "		Hornblende	.10
9	6	4750	Bunsen Burners, for gas	1.50
	15 ft.	5510	Rubber Tubing, 3/16 inch (Or 6 No. 5330 Alcohol Lamps, 4 oz., $1.38)	.90
	1	5898	Spool Steel Wire, 4 oz., No. 22	.15
	1 lb.		Calcite	.10
	1 lb.		Gypsum	.10
	1 "		Sulphur	.10
	1 "		Halite	.10
10	6	4560	Blow Pipes, 10 inch	.54
	6	1821	Horseshoe Magnets, 3 inch	.60
	12	4581	Charcoal Sticks	.50
	1 ib.		Hematite	.15
	1 "		Limonite	.15
	1 "		Magnetite	.10
	1 "		Pyrite	10
	1 "		Malachite	1.30
	1 "		Azurite	1 00
	1 "		Chalcopyrite	.50
	1 "		Galena	.25
	1 "		Spahelrite	25
11	6	8040	Pocket Magnifiers	2.10
	1 lb.		Sandstone	.10
	1 "		Congolomerate	.25
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26	6		Boxes Colored Crayons, 7 in box; brown, purple, blue, red, yellow, green, olive	1.20
28	6	4604	Bottles, 4 oz., with one hole rubber stoppers to fit	.45
	12	5235B	Glass Tubes, diameter ¼ inch, 8 inches long	.15
	1 lb.	5850	Paraffine	.16
	6	2236	Glass Tumblers	.30
29	3	1488	Pieces Rubber Dam, 6x8 inches	.36
	6		Saucers	.30
	3	5150	Funnel Tubes, Thistle Top	.24
	1	4041	Harvard Trip Balance	6.00
30	3	4602	Bottles, wide-mouth, 16 oz	.21
	3	5505	Rubber Stoppers, two hole, to fit above bottles	.45
	3	5235	Glass Tubes, 30 inches long, diameter ¼ inch	.15
	3	5235D	Glass Tubes, bent at right angles. Long arm 6 inches, short arm 3 inches	.30
	1 lb.	5843	Mercury	1.10
	2	1206	Barometer Tube, cup and pipette	.72
31	1	1212	Barometer with electric attachment for reading the zero point (or No. 1212A Barometer without electric attachment, $12.00.)	15.00
32	3	5811	Students' Lamp Chimneys	.18
	12	5803	Candles	.16
33	6	4516	Beakers, with lip, 8 oz	.78
34	1 lb		Alcohol	.75
	3	5650	Thermometers,–10° to 110° C.	1.08
	12	5332	Lamp Wicks	.08
	1 yd.		Cotton Cloth	15
35	3	5100	Flasks, flat botom, 8 oz	.36
	3	5505	Rubber Stoppers to fit above flasks	.30
	1 lb.		Salt	.15
46	1	113	Hammer	.45
48	3	5002	Evaporating Dishes, 3 inch	.36
			Total for all Equipment	$88.25

EXERCISE I.

CONSTRUCTION OF ANGLES

Purpose. To become familiar with angular measurement and to construct various angles.

Material. Pencil, rule, protractor, dividers.

Directions. 1. Draw circles having diameters of six inches, four inches, and two inches respectively. How many degrees in the circumference of each circle?

2. Divide each circle into four equal parts or quadrants. How many degrees in each?

3. Suggest reasons why 360 has been chosen to represent the number of degrees in a circle. Can you suggest any number which would seem more desirable?

4. With the aid of the protractor construct angles as follows: 90°, 75°, 60°, 45°, 30°, 20°, 10°, 23½°, 47°, 66½°.

5. Using ruler only, try to construct an angle of 45°. Test your drawing with the protractor. Likewise construct and test angles of 23½°, 47°, and 66½°.

Notes and Drawings

EXERCISE II.

EARTH FORM

Purpose. To illustrate different ways in which to prove the sphericity of the earth.

Material. Globe, cylinder, cube, disk, ball.

Directions. (a) Trace course of Magellan's journey around the world by finding on a globe or world map the following places through which he passed: Canary Isles, Sierra Leone, Pernambuco, La Plata, Port St. Julian, Cape Virgins, Ladrone Islands, Borneo, Moluccas, Cape of Good Hope.

1. Can any single journey around the earth be considered proof of its **sphericity?**
2. What did Magellan's journey prove?

(b) To observers at the Equator, the North Star appears at the northern horizon and to an observer at the North Pole it would be seen at the zenith.

1. How would the altitude of the North Star vary as seen by an observer traveling northward from the Equator? From a great number of observations taken, this angular height is found to vary at a practically uniform rate with distance.
2. Suppose that the earth were egg-shaped. Then to an observer traveling from Equator to the North Pole, where would the altitude of the North Star increase slowly? Where very rapidly?
3. In like manner suppose the earth were a cylinder. How would the angular height of North Star vary?
4. Could any other than a **spherical body** give the results described in the first question?

(c) 1. Note shadows cast on the wall by the following objects: cylinder, cube, disk, ball.

2. How many of the objects would cast a circular shadow in some position?
3. Which would cast a circular shadow from all positions?
4. Recall some lunar eclipse that you have witnessed. What was the shape of the shadow cast by the earth upon the moon's face?
5. Would the observation of only one eclipse prove the sphericity of the earth?
6. Would the observation of many such eclipses make the conclusions quite certain? **Why?**

Summary

1. Which of above lines of argument seem most conclusive?
2. Enumerate such other proofs as you may be able to recall.

Answers

EXERCISE III

THE EARTH'S ORBIT.

Purpose. To construct an ellipse to scale showing the correct shape of the earth's orbit about the sun.

To illustrate relative sizes of sun, earth, and earth's orbit.

Material. Thread, rule.

Suggestions. Look up meaning of focus, orbit, ellipse.

Directions. 1. The distance of the earth from the sun varies during the year from 91,500,000 miles to 94,500,000 miles. In representing the path of the earth around the sun on ordinary sized paper a scale of 1 mm. to a million miles will usually be found convenient. Why will the foci of the ellipse then be 3mm. apart?

2. Set one pin firmly near the center of the page. Set another pin 3 mm. north of the first. Take a string and make a loop 94½ mm. long, the string must of course be twice that length. Pass the loop over both pins, set as directed, and with your pencil at the other end of the loop draw an ellipse. Be careful to keep the string uniformly taut and not allow it to slip up on pins or pencil. You have drawn an ellipse which represents the earth's orbit around the sun.

3. The diameter of the sun may be taken as 866,000 miles and that of the earth as 8,000 miles. In the diagram as made and to the same scale how large a circle would represent the sun? Draw it around the north focal point. Why is it not practical to represent the earth to scale on this drawing?

4. If a floor space sixteen feet in diameter is available the drawing can be made on it with a scale of 1 inch to a million miles, being careful to use a string that does not stretch. The length of the loop would then be 94½ inches. Nails can be used instead of the pins.

5. It is an interesting experiment to try out of doors on a plat of fairly level ground using a scale of 1 foot to a million miles. What would be the length of loop to be used?

6. For each of last two ellipses compute diameters of circles to be drawn to represent the sun and earth.

Notes and Drawings

GENERAL EARTH STUDIES

EXERCISE IV

THE EFFECTS OF THE ROTATION OF THE EARTH

Purpose. To determine causes for positions of equator and poles and to illustrate the illumination of the earth's surface and the location of meridians and parallels.

Material. Small globe.

Directions. A. Locate the following points on the globe: (1) the intersection of the meridian of Greenwich and the equator; (2) intersection of the same meridian and parallel 45° north; (3) intersection of the same meridian and parallel marking 90° north.

1. Rotate the globe once. Compare the **time of rotation** for the three points. Compare the **distances** thru which the points move in each rotation.
2. What term should be used for the points of minimum velocity?
3. What circle is determined by the points of greatest motion?
4. How many degrees are there between the fastest and slowest moving points?
5. Infer why circles determined by intermediate points are called **parallels** of latitude?
6. How will the parallels compare in size (measured in miles) with the equator? In number of degrees?

B. With the axis vertical hold the globe in a beam of sunlight or where the rays from a lighted lamp may strike it.

1. How much of the total surface is illuminated? Of the equator?
2. Notice the borders of the illuminated area. Infer what is meant by circle of illumination.
3. How must the earth rotate in order that sunrise may be seen in the east and sunset in the west?

C. The time necessary for the earth to make a complete rotation is considered to be one day.

1. Upon how many degrees of the equator does the sun shine in one day? In one hour? In four minutes?
2. Thru how many degrees do all points rotate in one day? In one hour? In four minutes?

Answers

EXERCISE V.

LONGITUDE AND TIME

Purpose. To consider in a practical way the relation of earth's rotation to time at different places.

Material. Outline map of United States; outline map of the Pacific ocean.

Suggestions. The following problems may be used as the basis of a class recitation or as a laboratory study as is thought best. Pupils should be able to discuss intelligently all the principles involved.

Problems. 1. When the sun is just rising at your home town, is it before or after sunrise to the east of you? Earlier or later by solar time? Likewise state conditions to the west of you.

2. When the sun is just setting at your place is it before or after sunset east of you? West of you?

3. When it is 12 M (solar time) at Lincoln, Nebraska, where is it 9 a. m.? 10 p. m.?

4. When it is 1 p. m. at Washington, D. C (longitude 77° west), it is 9:58 a. m. at San Francisco. Work out longitude. Verify with atlas.

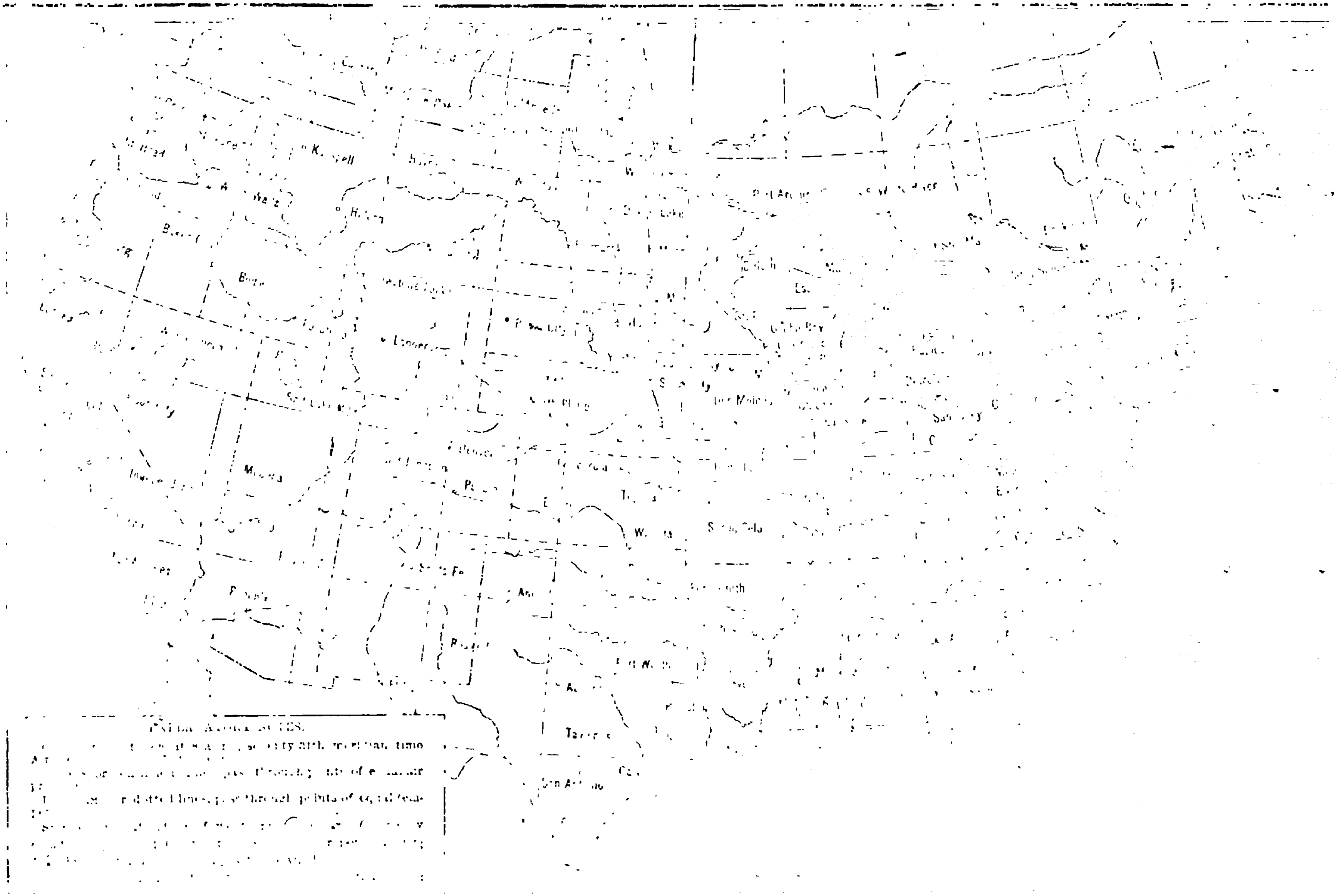
5. On the outline map of the United States, draw in heavy lines the meridians of 75°, 90°, 105°, and 120° W. long. These have been chosen as the central meridians for standard time belts. Suggest reasons for the choice. Of what use is standard time? Why very important for railroads?

6. In which standard time belt do you live? Are you east or west of your central meridian? How much? Is your local "sun" time faster or slower than standard time? How much? Why?

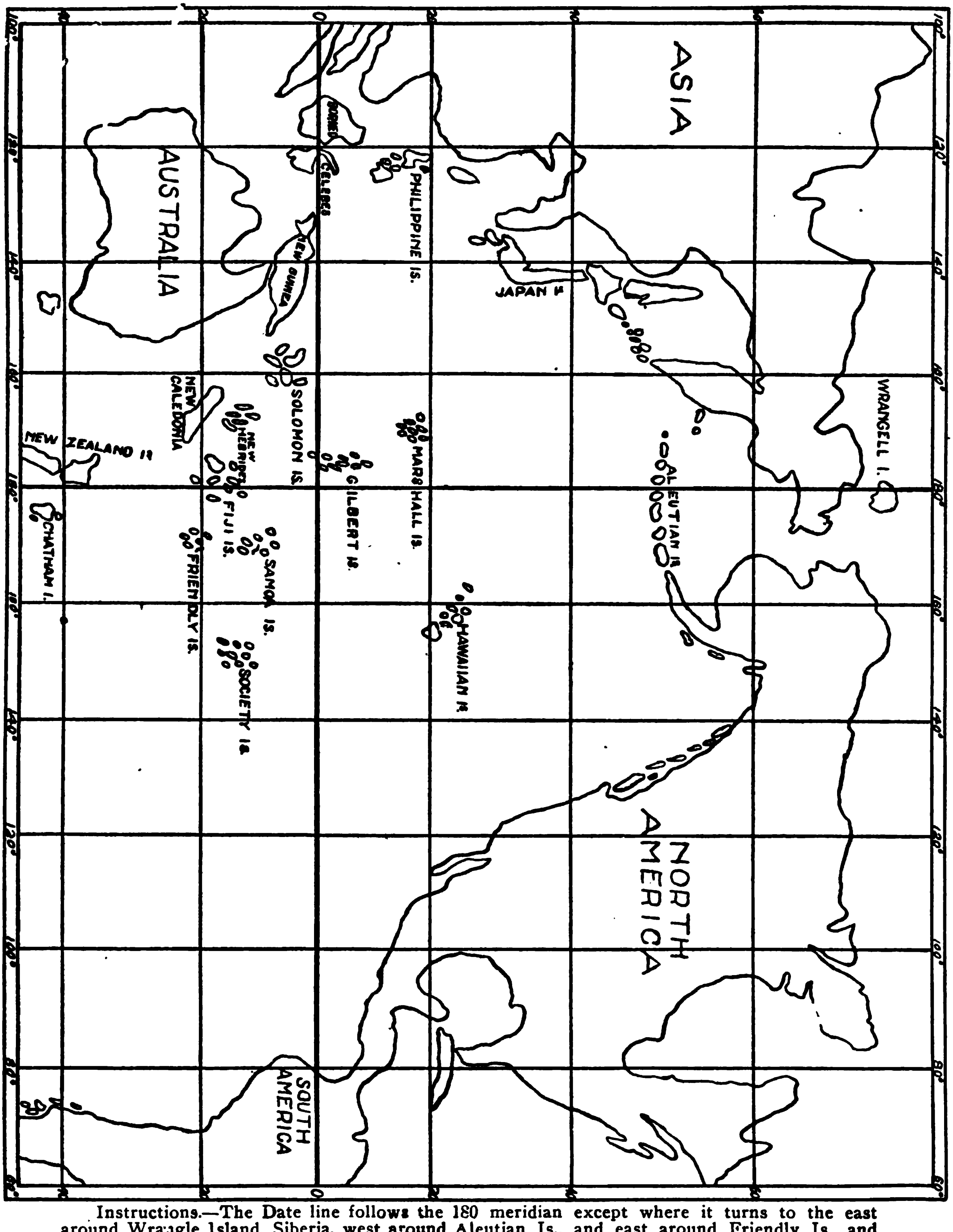
7. At certain places the railroads make their changes from one time belt to another. Study railroad time tables and see if you can find any such places? What changes are made in tables for trains going east? West?

8. On accompanying map locate the International Date Line. Aside from a few irregularities it practically coincides with the 180th meridian. Why is its location well chosen? Explain the reason it does not always follow the 180th meridian. On the east side of the Date Line write Sunday. What day should you write on the west side?

Answers


Kalispell
Helena
Boise
Salt Lake
Denver
Des Moines
Santa Fe
Phoenix
Wichita
Fort Worth
San Antonio
Lander
dotted lines pass through points of equal

OUTLINE MAP OF PACIFIC OCEAN—For Date Line



Instructions.—The Date line follows the 180 meridian except where it turns to the east around Wrangle Island, Siberia, west around Aleutian Is., and east around Friendly Is., and Chatham Is. Mark this path.

EXERCISE VI

PHASES OF THE MOON

Purpose. To illustrate relative positions of sun, moon, and observer at the different phases of the moon.

Material. Rule, dividers, almanac.

Suggestions. Before beginning the construction work the student should become familiar with the following terms: Cardinal points, semi-cardinal points, crescent, gibbous, waxing, waning.

Directions. With a convenient radius, about 3½ inches, describe a circle to represent the moon's orbit. Place a dot marked 0 in the center of the circle to represent the observer. Upon the circumference, representing the moon's orbit, locate by dots the cardinal and semi-cardinal points.

1. (a) How many days from one full moon to the next full moon? Consult an almanac if in doubt.

(b) Infer the number of days necessary for the moon to make one complete revolution about the earth.

2. In the diagram above representing the moon's orbit, how many days would it take for the moon to pass from one cardinal point to the next? From a cardinal to a semi-cardinal point?

3. Upon the circumference, with the cardinal and semi-cardinal points as centers, construct circles having ½-inch radii to represent the moon at these positions in its orbit. Number these circles 1 to 8, beginning at the right. The distance from the earth to the moon is about 240,000 miles. What is the diameter of its orbit?

4. Suppose the sun to be at the right of your page. On account of its size (diameter, 866,500 miles) its rays may be imagined as coming parallel. Shade the left halves of the moon circles representing the portion that does not receive the sun's rays.

5. How much of the illuminated portion of the moon in position 1 is visible to the observer? What phase of the moon is this? (new moon, first quarter, full moon, or last quarter).

6. As the moon moves from 1 to 2 does the visible, illuminated portion increase or decrease? Is it waxing or waning?

7. Name the phase of the moon represented in each cardinal position. For semi-cardinal positions identify waxing crescent, waxing gibbous, waning gibbous, waning crescent.

8. For each cardinal position make a small sketch to illustrate the appearance of the moon to the observer.

9. Do you see the new moon in evening or morning? The old moon? What are the relative positions of sun, moon, and earth, at the time of the new moon? At time of full moon?

10. Of what use is the moon to man?

Drawings and Notes

MATERIALS OF THE LAND

EXERICSE VII

MINERALS I

Purpose. To study the characteristics of some of the important common rock-forming minerals.

Material. Rose quartz, milky quartz, quartz crystal, flint, agate, smoky quartz. Piece of glass. Hydrochloric acid (H Cl) test tube.

Suggestions. Before beginning a study of the specimens it is essential to know the meaning of some of the terms to be used. Supplement the following notes by whatever reading the text used may afford. Some elementary texts in minerology should be available for reference purposes. The following are suggested as being especially valuable: "Common Minerals and Rocks"—Crosby—D. C. Heath & Co. "Rocks and Rock Minerals"—Pirsson—Jno. Wiley & Sons. "Minerals and How to Study Them"—Dana—Jno. Wiley & Sons. "Rock Minerals" —Iddings—Jno. Wiley & Sons. "The Non-Metallic Minerals"—Merrill—Jno. Wiley & Sons.

Important Properties—Cleavage. When minerals tend to break more easily in some directions than in others they are said to have **cleavage.** What does the word cleavage mean? Cleavage may be in one, two or three directions, as shown by mica, orthoclase, feldspar, and calcite or rock salt.

FRACTURE. The nature of the surface given by the breakage of minerals in directions which are not those of cleavage is called its fracture. Terms used to describe fracture are:

Conchoidal. For fracture surface presenting a shell-like appearance such as is often seen on surfaces of broken glass which reminds one of a clam shell. Conchoidal fracture is frequently characteristic of dense, compact, and homogeneous rocks and minerals. It is often well shown in lignite coal.

Uneven. When the fracture surface is rough and irregular.

Splintery and earthy. Terms used when the fracture surface is best described by such expressions.

Hardness. For our work the following tests will be sufficient, finger nail, point of knife blade, glass.

Color. The color of minerals may be due to their chemical composition, in which case it is a good test. But it is often due to the presence of foreign matter of high coloring properties, in which case it cannot be used as a test. This is often the case with the common minerals, quartz, feldspar, and calcite. White is not often regarded as a color, being due frequently to reflection of light from the surfaces of innumerable microscopic cracks which permeate the mineral.

LUSTER. The appearance of the surface independent of the color due to the way light is reflected. These terms are most commonly used:

Metallic: The luster of a metallic surface as of steel. The term is only used for opaque minerals—those which do not transmit light, even through very thin edges.

Vitreous: The luster of a piece of broken glass. Characteristic of many non-metallic minerals.

Resinous: The luster of a piece of resin.

Silky: The luster of a skein of silk or a piece of satin.

Streak. This term refers to the color of a mineral when reduced to powder, which is often different from the color of the mineral in the solid form.

Directions. Quartz. 1. Will it scratch glass? All minerals that will readily scratch glass may be classed as very hard.

2. From study of broken surfaces can you find evidences of conchoidal fracture?

3. Does it have cleavage?

6. Try to dissolve a small piece in water. State results.
7. Does it have any taste?
8. Test with Hydrochloric acid for effervescence of other signs of chemical activity.

Caution. Whenever testing any mineral with acid it is preferable to take a small piece or a little of its powder in a test tube. **Never put acid on specimens which are to be handled by others.**

9. From references find out what are the essential chemical elements of quartz.
10. Note special characteristics of each variety studied. How do you account for differences in color?
11. Do you think quartz would make a weak or durable rock?
12. Look for quartz in sand, gravel, and soil in your vicinity.

Results

MATERIALS OF THE LAND

EXERCISE VIII

MINERALS II

Purpose. To study the characteristics of some of the important common rock-forming minerals.

Material. Orthoclase, Muscovite, Biotite, Hornblende, Piece of glass, HCl, Test Tube.

Suggestions. Review the terms used and the minerals studied in Lesson VI.

Directions. Feldspar: Orthoclase.

The term, Feldspar, meaning "rock of the field," designates a group of minerals of which the most common is Orthoclase. The Feldspars are especially important because when they decompose they yield clay as one of the principal products.

1. Describe the color and luster.
2. Will it scratch glass? Is it as hard as quartz?
3. Describe its cleavage as to (a) number of planes (directions in which it cleaves); (b) angle of planes, whether right or oblique.
4. Test with HCl. Note results.
5. What is likely to be the effect of the cleavage planes upon its durability?
6. Do you think it as durable constituent of rocks as quartz?
8. From sand or gravel specimens which may be available, look for bits of feldspar.

Mica. Muscovite, Biotite.

1. What is the color of Muscovite? Biotite?
2. Will either scratch glass?
3. Describe the cleavage of micas as to (a) number of planes; (b) readiness with which they may be cleaved.
4. Take a small piece of mica and bend it. (a) Does it break easily? (b) When bent, is there evidence of elasticity shown when released?
5. Test with HCl.
6. Look for flakes of mica in sand; in the soil.
7. What are some important uses of mica?

Hornblende. The color of Hornblende is a very important property.

1. Compare its hardness with Quartz; with Biotite.
2. Is it attracted by a magnet?
3. How would you distinguish between Hornblende and Smoky Quartz? Between Hornblende and Biotite?

Results

EXERCISE IX

MINERALS III

Purpose. As in Exercises VII and VIII.

Material. Calcite, Gypsum, Halite, Sulphur, Wire, Pieces of Glass, HCl, test tube. Bunsen burner or alcohol lamp.

Directions. Calcite. Calcite is one of the most common and widely diffused of all minerals. It is found to some extent in nearly every class of rock, and forms the greater part of chalk, limestone, and marble.

1. (a) Will it scratch glass? (b) Steel?
2. How many cleavage planes are apparent?
3. Are the angles between the cleavage planes right or oblique angles?
4. Test with HCl. Describe result.
5. Infer what the effect of acid waters would be on calcite and on rocks composed chiefly of calcite.
6. Contrast calcite and quartz as to hardness; effect of HCl.

Gypsum. 1. Take a small piece and note the sensation when ground between the teeth. Does it feel gritty?

2. Describe the taste.
3. Test with HCl. Contrast with calcite.
4. Look up the meaning of **calcining.** What are some of the important uses of gypsum?

Halite. (Rock Salt). 1. Is it as hard as quartz? Calcite? Gypsum?

2. What is its color when pure? To what are other colors due?
3. Contrast its cleavage with calcite.
4. Note taste and solubility.
5. Take a little salt solution on the end of a clean wire and hold in a flame, preferably from a Bunsen burner or alcohol lamp. Note the characteristic yellow flame known as the sodium flame.
6. What are the important uses?

Sulphur. 1. Describe color.

2. How does its hardness compare with calcite?
3. Heat a small piece and note the color of the flame and odor of the gas.

Results

EXERCISE X

MINERALS IV

Purpose. To study the characteristics of some of the common metallic minerals.

Material. Hematite, Limonite, Magnetite, Iron Pyrite. Ores of copper, lead and zinc. Magnet. Alcohol lamp, Blowpipe, Charcoal.

Directions. Hematite, Limonite, Magnetite. These are the most common iron ores, and yield the greater part of the world's supply of iron. Their essential chemical constituents are iron and oxygen chemically united.

1. Describe color of each specimen.
2. Crush a little of each into powder. State color.
3. Test the powder with a magnet. Which is attracted?
4. How may magnetite be distinguished from other dark minerals?

Iron pyrite. 1. Infer why it is called "fool's gold."

2. Heat a small piece with a blowpipe on charcoal, or hold in a flame with a pair of forceps. What change occurs? How may this test be used to distinguish it from gold?

3. Touch a piece of partly weathered pyrite to the tongue and note the taste.

4. Look for pyrite in coal.

Other ores. Study as many ores of other metals as may be available. The following are suggested:

Copper. Malachite, Azurite, Chalcopyrite.

Zinc. Sphalerite (Black Jack).

Lead. Galena.

SUMMARY

Be able to identify each mineral studied and to state its characteristic properties and principal uses.

Results

EXERCISE XI

STUDY OF COMMON SEDIMENTARY ROCKS, I

Purpose. To emphasize the important characteristics of a few common rocks.

Material. Sandstone, Conglomerate, HCl, Lens.

Notes. Sandstone belongs to the arenaceous or sandy group of sedimentary rocks. They are composed of grains of some mineral, usually quartz, held together by some cementing substance. The fracture takes place chiefly in the cement, leaving the grains projecting, which give the rock its peculiar appearance and feeling.

The colors are very variable depending largely on the nature of the cement. In the yellow, red, or brown sandstones the oxides of iron predominate, while with lighter colors calcareous, argillaceous, or siliceous cements are of chief importance.

Sandstone has a wide use as a building material. The ease with which it is worked and the large blocks which may be quarried make it very valuable. The red and brown sandstones are much in demand because of their lasting uniformity of color. Gray sandstone, if free from iron, is also in high favor.

Directions. 1 Examine a specimen of sandstone closely, preferably using a small lens. Is its texture close or open? State color of particles. Are there spaces between them?

2. Crush a small piece. Are the grains angular or rounded? If fragments are not clean wash them in water in a test tube. Note effect. About how large are the grains? Do they vary much in size?
3. Test for hardness by rubbing a bit of sandstone on a piece of glass.
4. Using the crushed portion, try to recognize the minerals in the rock. Which seems to predominate?
5. Test a part of the crushed portion with HCl.
6. How is sandstone probably formed?
7. Examine a specimen of conglomerate, noting shape and arrangement of particles, hardness and mineral content. Judging by their size and form what can you infer as to previous history of particles?
8. Upon what does the durability of sandstone depend?
9. Look for specimens of sandstone in your vicinity.
10. What kind of soil would result from weathering of sandstone?

Results

EXERCISE XII

STUDY OF COMMON SEDIMENTARY ROCKS, II

Purpose. As in Exercise XII.

Material. Limestone — fossiliferous, compact. HCl. Lens. Glass.

Notes. Calcareous rocks.

Limestones are the most common calcareous rocks. They vary widely in many respects, due to differences in origin and kinds of impurities, hence we have many varieties. Some contain much clayey matter and are therefore called **argillaceous** limestones, while for those containing much sand the term **arenaceous is used.** The essential constituent of limestone is calcium carbonate.

The uses of limestone are so wide and varied that only a few of them can be enumerated here—among them: Structural purposes, burning into lime, making of cements, etc.

Directions. 1. Examine the specimens carefully with a lens. Are the grains as distinct as in sandstone?

2. Are the limestones rougher or smoother to the touch than sandstone?

3. Determine whether limestone will scratch glass or be scratched by it. Test also with a knife blade.

4. Test a small fragment of each specimen with HCl. Evidently what mineral is an essential constituent? (Recall Exercise VIII.) Pulverize a small piece, place in test tube or beaker, and try to dissolve it in HCl. About what percentage will not dissolve?

5. How many different kinds of fossils can you find?

6. Summarize the essential distinctions between sandstone and limestone.

7. Name as many places as you can in your vicinity where limestone is found or used. Wherever possible study its properties, fossils, and durability.

8. Why is limestone used so extensively in buildings?

Results

EXERCISE XIII

STUDY OF COMMON SEDIMENTARY ROCKS. III

Purpose. As in Exercise XII and XIII.

Material. Shale. Clay. HCl. Glass.

Notes. The characteristic odor when breathed upon is one of the most important common tests for clay. Other means of recognizing it are: (1) that it produces a soft, greasy feeling when strongly rubbed to a powder; (2) it clings to the tongue; (3) it eagerly absorbs water, and when wet is plastic. Pure clay is white but it is usually colored by iron or organic impurities.

When muds and clays have become compact so that they possess a more or less thinly laminated structure they are termed shales. The parting is parallel to the bedding and is the result of natural stratification. Shales usually contain a high percentage of clay, but may also contain considerable organic matter, sand, or carbonates, in which cases they are termed carbonaceous, arenaceous, or calcareous.

Clays and shales, in addition to their importance as soil formers, are extensively used in making brick, tile, terra cotta, and pottery. During recent years they have also become of great importance in connection with limestone in the manufacture of Portland cement.

Directions. 1. Examine the specimens carefully with a small lens, noting size and arrangement of particles.

2. Test hardness with the finger nails.

3. Rub a little of the powder of each specimen between the fingers. Is the feel smooth or gritty?

4. Test with HCl. If any effervescence is noted, what constituent is indicated? Pulverize a small piece and place in a test tube, then apply HCl, and note approximately the percentage that will dissolve.

5. Breathe upon a portion and note characteristic odor.

6. Wet a small piece and note plasticity.

7. To what are the colors of the specimens probably due?

8. Is there any evidence of planes of stratification along which the specimens cleave readily? How account for them? Contrast, in this particular, clay and shale.

9. How can you distinguish clay and shale from limestone? From sandstone?

10. Would clays and shales give light or heavy soils upon weathering?

Results

MATERIALS OF THE LAND

EXERCISE XIV

IGNEOUS AND METAMORPHIC ROCKS

Purpose. To study characteristic properties of granite, quartzite, marble and slate.

Materials. Specimens of each rock. HCl. Lens.

Directions. Granite. Granites are probably the most widely known of the igneous rocks. They are crystalline rocks composed essentially of feldspars and quartz generally associated with some other minerals.

Granites form the core of many of the great mountain regions, and are common in those parts of the earth's surface where great disturbances and enormous erosion have occurred. Hence they are common in Eastern Canada, New England, the Piedmont region, Wisconsin, the Blacks Hills, and the Rocky Mountains.

At least two general kinds should be at hand, the coarsely crystalline and the fine textured. Granite is classed as an igneous rock.

1. Try to identify the mineral content. Look especially for quartz, feldspar, and mica. How is each recognized? Which will most strongly resist weathering?
2. Are the different minerals held together by any cementing material or are they in direct contact? Contrast with sandstone.
3. Test for hardness. Also note effect, if any, of HCl.

Quartzite. Quartzites are essentially quartz-sand rocks wherein the sand particles are firmly cemented with silica, that is, deposited quartz. They occur in regions of extensive metamorphism such as eastern North America and in the Rocky Mountains. Sioux Falls, South Dakota, is an important outcrop for Iowa, Nebraska, and Kansas, because of the boulders brought from there by glacial action.

1. With a lens note size of particles. Are they as distinct as in sandstone? Note spaces between grains. Are they open or filled?
2. Place a drop of water upon it. Infer concerning its compactness. Test with HCl.
3. What reasons do you see in favor of its use for building purposes. What difficulties?
4. How can you distinguish between sandstone and quartzite?
5. What kind of soil would result from weathering of quartzite?

Marble. Crystalline, granular rocks composed of grains of calcite are known as marbles. Sometimes the calcite grains or crystals are held by a calcareous cement. The crystals may be very fine or very coarse. Pure marble is white, but other colors are very common, due to impurities consisting chiefly of iron oxides or carbonaceous materials.

Marble is found in large quantities in Vermont, Massachusetts, Georgia, Tennessee, Colorado and other places in the west, as well as in Canada and many European countries. The marbles of Italy and Greece have long been very famous for statuary and building purposes.

1. Test a small piece with HCl. What percentage dissolves? What is the chief constituent?
2. Recall the color of pure marble. Account for the color of the specimens in hand.
3. At your next opportunity look for evidence of weathering on a marble monument which has stood for a number of years.
4. Infer as to the durability of marble as compared with granite; quartzite; sandstone.
5. For what uses is marble best adapted?

Slate. Slates are the metamorphosed forms of the finest material of the land waste by erosion. Among the unmetamorphosed stratified rocks we find this waste, as mud, clay, or shale. Slates are found in many places in the United States, but are being quarried most extensively in Maine, Vermont, New York, Pennsylvania and Georgia.

EXERCISE XIV (Continued)

1. What resemblance does it bear to shale and clay?
2. Compare its compactness with shale. Test with a drop of water.
3. Place a fragment on the tongue. Does it cling to it as does clay?
4. Breathe upon it. Is any odor noticeable? Compare with clay.
5. Pulverize a piece of slate. Does it become plastic when wet?
6. Can you scratch it with the thumbnail?
7. Test with HCl. Is any effect apparent?
8. Why can slate and not shale be used for blackboard and roofing?

Results

EXERCISE XV

THE TOPOGRAPHIC MAP I

Purpose. To teach familiarity with different features shown on topographic maps.

Material. York (Maine) Sheet. Ruler.

Suggestions. On the back of each sheet is printed a description of the Topographic Map of the United States. This description outlines briefly the history of the work, its purpose and accomplishments, and gives a concise discussion of terms used and their significance. Below the description is a legend which gives the conventional signs used on the map. On some sheets the legend is placed along the margins of the map. Read the description carefully, and then study the legend in connection with the map. Observe that the signs are given in three groups—under Water, Culture, and Relief.

Contours are lines which pass through points of equal altitude. If one should follow a contour on the ground he would go neither up or down, but on a level. The contour interval, or the **vertical** distance in feet between one contour line and the next, is stated at the bottom of each map. Certain contours, usually every fifth one, are accentuated and are accompanied by figures stating elevation above sea-level.

The area shown on a map is known as a **quadrangle,** while the term **sheet** is usually applied to the map itself. Hence the York Sheet is the map of a **quadrangle** of land in which York is located. The sheets are generally designated by the name of a principal town or some prominent natural feature within the district.

The **scale** is also stated on the lower margin of each map, as well as a line interpreting it The scale of the York Sheet is 1/62500, which signifies that one inch of linear distance on the map represents 62500 inches in the field. This is approximately one inch to the mile. How many feet in one mile? Inches? Other scales used are 1/125000 and 1/250000 respectively. A scale is called large or small as the value of the fraction expressing the scale is high or low. Which of the three suggested, would be the largest scale map?

Directions. 1. Why is this called the York Sheet?

2. Observe figures at each corner. Which show latitude? Which longtitude? By means of them locate this area on a map of New England.

3. What is the scale of the map? About what distance stands for a mile?

4. How many miles long is the area shown on the map? How wide? Does this map show much or little country compared with most maps you have seen?

5. What water features are shown? In what color are they printed?

6. What culture features are shown? By what color are they represented?

7. What contour interval is used? What contours have the elevation stated on them? Why not all?

8. What is the altitude of the shore line? Trace the shoreline between Bald Head Cliff and Weare's Point. How does it curve where the little streams enter the ocean?

9. What is the altitude of the contour nearest the shoreline? For same region as in question 8, trace the course of lowest contour. How does it curve, upstream or downstream, where it crosses streams or valleys? Study other contours. Are similar curves noted? Explain.

10. What is the altitude of some of the highest places on the map?

EXERCISE XV (Continued)

11. How may a contour represent a hilltop? Find examples.

12. Where contours are close together is a steep or gentle slope indicated? Where contours are far apart what kind of a slope?

13. What is the altitude of the source of Josius River? In what part of its course is its fall steepest?

14. When contours cross a stream do they bend up stream or down stream?

15. When contours pass around a ridge do they bend away from the summit or toward it?

Answers

EXERCISE XVI

THE TOPOGRAPHIC MAP—II

Purpose. To furnish drill exercises such as will enable pupils to readily interpret relief features shown on topographic maps.

Material. Sand or clay. Board or shallow pan. Pan or dish about four inches deep. Blocks of wood about an inch thick. Rule.

Suggestions. First part, A, of this exercise should be performed by teacher in presence of class.

Directions. A. Out of clay or sand, shape hill on a small board or shallow pan, so that it will have a ridge extending from the summit down one slope, and have a valley cut into one side. Let the hill be a little over four inches high. Fill a dishpan or similar vessel with water and set model into it. The hill should be high enough that a portion of it will project above the water's edge. With a pencil trace the water's edge on the model. Then put blocks under the model and elevate it one inch. Now, what is the altitude of all points on the line traced on the model before elevation? What name may be given to the line? Trace as before, the water's edge in this second position. By placing another block elevate the model one inch more. Again trace water line. Repeat until the model is entirely out of the water. Note the curve of contours on the model where they cross the valley; where they pass around the ridge. What kind of a contour denotes the top of the hill?

If it is not practicable to submerge the model as outlined, similar results can be obtained as follows: Place an inch block on the base of the model and lay a straight pointer, about a foot long, on top of the block. Move it so that the pointer will just touch the model and make a mark around it. All points on the line will be how much above the base of the model? What name may be given to this line?

Place a second block under the pointer and proceed as before. Repeat until entire hill has been covered.

What contour interval has been used in these cases?

B. 1. Draw a map of the surface of the model as you would see it from above. Choose a convenient scale.

2. Draw a topographic map of a round hill 600 feet high. Contour interval, 50 feet.

3. Draw a topographic map of a hill one mile wide, two miles long, maximum altitude 300 feet. Contour interval, 20 feet. Choose scale.

4. Draw a topographic map of a gently sloping plain having a stream and tributaries flowing down the slope. Choose altitudes, dimensions, scale, and contour interval.

Notes and Drawings

LAND FORMS

EXERCISE XVII

A YOUNG LAKE PLAIN

Purpose. To study the characteristics of the topography of a newly exposed lake plain.

Material. Fargo Sheet. Rule.

Suggestions. The greater part of the area shown on this map is a typical portion of the plain drained by the Red River of the North. During the period of the glacial invasions this valley had its outlet dammed by ice, thus causing a lake to be formed. Streams flowed into this lake from the surrounding uplands and the melting ice, carrying sand, mud, and silt which was deposited rather evenly on the lake bottom. When the glacier retreated farther north, the lake drained into Hudson Bay, leaving the lake bottom a plain exposed to the forces of weathering and erosion.

Studies. I. General Map Features. 1. What is the scale of the map? Contour interval?

2. Give latitude and longitude of map boundaries. Locate the area on a large map of the United States.

3. How long is this quadrangle? Wide? What is its area?

II. Topography and Drainage. 1. Do the contours indicate slight, moderate, or great relief?

2. What is the general direction of the streams of this region?

3. Why do not the main streams have many tributaries? As erosion progresses, what will become true?

4. South of Fargo, point out some examples of "young" tributaries. What changes will occur in these little valleys? Give reasons why you think they will deepen or be fillled in, become larger or shorter, narrower or wider.

5. What is the general form and depth of main stream valleys? Are the divides flat or formed into hills and ridges? What changes will occur as erosion proceeds?

III. Culture Features. 1. Does this type of topography render railway construction easy or difficult?

2. Why are the wagon roads laid out on the rectangular plan?

3. Ordinarily valleys serve as highways. Is any such relation shown here?

4. Recalling climate, topography, and soil conditions adapted to wheat culture, state reasons for this being an important wheat growing district.

IV. Summary. 1. In a very young plains topography which serve as the better highways, the valleys or the divides? Why?

2. Taking into consideration present altitudes and climatic conditions, can this region ever become very rugged?

Answers

LAND FORMS

EXERCISE XVIII

MATURE PLAINS TOPOGRAPHY

Purpose. To study topographic features of a highly dissected plains region.

Material. Kanawha Falls Sheet.

Suggestions. This quadrangle is a part of an extensive region stretching from New York to Alabama, known in the north as the Catskill-Alleghany Plateau, in the south as the Cumberland Plateau. This plateau region forms the western member of the Appalachian highland region. The map represents the typical topography of the region north of Kentucky and where the plateau merges into the plains west of the Alleghanies. The rocks in this region are nearly horizontal, having but a gentle dip to the northwest, and are nearly of the same hardness. These facts show that this area was formerly a plateau sloping gently in the direction of the dip of its rocks, its surface being otherwise nearly level or slightly undulating. The surface shown here is that of the region as it has been dissected by water erosion. Much of the land has been carried away by the streams. Upon the plateau a drainage system was developed in much the same way as we saw it being done in the Fargo area. But the slopes were steeper and rainfall much heavier, hence larger streams resulted. The streams, having steeper grade and greater volume, have greater power to do work, and hence erode the land more rapidly than would smaller or more sluggish streams.

Studies. 1. Give the latitude and longitude boundaries of the quadrangle.

2. (a) In what part of West Virginia is this region? (b) To what drainage system does it belong?

3. What is the scale of the map?

4. What is the contour interval? Compare with that used on Fargo Sheet.

5. (a) About what is the altitude of the highest points in the southeast part of the quadrangle? (b) In the northwest part? (c) What does this show as to general slope?

6. (a) Can you find many areas a mile square without streams? (b) Is there any portion where drainage seems imperfect?

7. What is the only river in the area which has any flood-plain?

8. (a) Are the divides broad or narrow? (b) Are the slopes steep or gentle? (c) How were these hills made?

9. The stratified rocks here contain a number of beds of coal. How will the number of ravines and waterways facilitate mining?

10. Does the number of streams indicate light or heavy rainfall?

11. Why are not the wagon roads laid out on the rectangular plan?

12. What controls the location of all highways and dwellings?

13. Is this topography well adapted to farming?

14. With continued erosion, will this topography become more or less rugged? Why?

Answers

EXERCISE XIX

OLD AGE TOPOGRAPHY

Purpose. To study topographic features of a region in the later stages of a cycle of erosion.

Material. Caldwell Sheet, Kansas.

Suggestions. This area has been selected for study because it is a representative type of advanced or old age topography. It is the problem of this exercise to study out the points of resemblance and of contrast to those of areas previously studied. Climatically this district lies in the sub-humid region. Irrigation is not necessary for successful farming. The surface is almost entirely devoid of native timber except narrow belts along the larger streams.

The original level of the country was undoubtedly much greater than its present level. When the rock layers that built up this region are examined they are seen to lie at a gentle inclination to the west. They all appear to have lost much of their original extension, which would carry them at a gentle ascent into the air far above the present surface. Upon an originally higher surface than the present we may imagine the streams commenced in much the same way as was seen in the case of the Fargo district by the establishment of a few drainage lines which subsequently became the courses of the principal streams. By drainage development a stage came when the topography was similar to that studied in the Kanawha Falls district—an alternation of deep gorges and narrow sharp ridges or divides. Still further erosion produced the present topography.

The fact of more advanced development of topography of this area does not necessarily mean that it is older in years than the Kanawha Falls region. Erosion has probably been more rapid here because the rocks are softer and the slopes are bare instead of forest covered. Time, after all, is not the factor we are studying.

Studies. 1. In what part of Kansas is this quadrangle located?

2. (a) What contour interval is used? (b) Does this indicate great or moderate relief?

3. Compare the number of contours with the number shown on the Fargo, and Kanawha Falls sheets.

4. Does the arrangement of contours indicate variable or uniform slopes?

5. Look for small closed-curve contours. (a) Are they numerous or scarce? (b) What does this show as to number of hilltops?

6. (a) Are there any large level tracts? (b) Any undrained areas?

7. Are the stream courses generally straight or meandering?

8. (a) As you approach these valleys is it easy to determine just where the valley sides begin? (b) Then would you classify them as gorges or open valleys?

9. Does any particular topographic form seem to have determined the location of railroads?

10. Note arrangement of wagon roads. What plan is generally followed? Why?

11. (a) Do any of the railroads encounter steep grades anywhere? (b) Does this type of topography favor or retard building of railways?

12. Is this type of topography favorable or unfavorable for agriculture?

Answers.

EXERCISE XX

A DISSECTED PLATEAU

Purpose. To study in detail a few of the characteristics of the Grand Canyon of the Colorado River.

Material. Bright Angel Sheet, Arizona.

Suggestions. The Grand Canyon of the Colorado River is probably the largest canyon in the world. It has long attracted explorers from all parts of the world and numerous articles have been published describing this great natural feature. Excellent descriptions and illustrations are found in early all physical geography texts. These should be studied carefully in preparation for this exercise. From a large map or atlas the whole course of the Colorado River should be noted, as well as the portion of its valley known as the Grand Canyon.

Studies. 1. In what part of Arizona is the quadrangle located?

2. What is the scale of the map? About what area is included?

3. What contour interval is used? What does this suggest as to relief?

4. About what is the altitude of the plateau in the northern part of the quadrangle? In the southern part?

5. What is the altitude of the Colorado River? Note that it is crossed by two contours on this map. Compute distance between them and determine the fall of the river in that part of its course.

6. Is the course of the river smooth or interrupted by many rapids? How shown?

7. What is the shortest distance from the south rim of the canyon to the river?

8. What is the depth of the canyon measured from the plateau on the north to the river?

9. How high is Shiva Temple above its base? Osiris Temple?

10. How does steepness of slopes of upper canyon compare with those of the inner gorge? In which part are the harder rocks?

11. How deep is the inner gorge? How wide at the top? At the bottom?

12. Note location of the village of Grand Canyon. Describe briefly your conception of the view to the north.

13. Trace the course of some of the trails leading from the town of Grand Canyon to the river.

14. How many trails are mapped as extending to the bottom of the inner gorge? Why do they have such a zigzag course?

15. What do the angular slopes indicate as to rainfall?

16. Why should this valley be classified as a great barrier rather than a highway?

Answers

EXERCISE XXI

THE PLATTE RIVER PLAIN.

Purpose. To study the features and economics of a typical alluvial plain, characteristic of the larger river valleys of the Great Plains.

Material. Lexington, Nebraska, Sheet.

Suggestions. The Platte River rises in the Rocky mountains of Colorado and Wyoming in two large branches known as the South Platte and the North Platte respectively. Their ultimate sources are at altitudes of 10,000 to 14,000 feet, where snow accumulates to great depths in winter, melting in May and June. The two branches descend very rapidly in their short mountain courses, the fall being about 45 feet per mile, but through the plains country the rate of descent is very much less, averaging only a little over 7 feet per mile. On account of the large quantities of water used for irrigation and that lost by evaporation the volume of the stream decreases in its course through the semi-arid plains, and increases by the addition of tributary waters only through the last one-third of its plains course.

Studies. 1. What is the area of the Lexington quadrangle? Of this how much is included in the Platte River floodplain?

2. What is the average width of the floodplain? Describe its topography.

3. About what is the fall of the river per mile in this area? Is this a high or low gradient for a river?

4. Is the course of the river in its floodplain straight or meandering? What reason can you give for this?

5. How high are the valley sides bordering the floodplain?

6. Is the carrying power of the river as great here as it is nearer its headwaters? What two factors must be considered?

7. How account for the braided course of the stream?

8. Notice curve of contours where they cross the channel. Is the river deep or shallow? Proof? Of what is its bed composed?

9. Note the lower courses of the small streams tributary to the Platte. How account for their flowing for long distances parallel to the main stream?

10. Does the Union Pacific railroad follow a divide or a valley? The Burlington and Missouri River Railroad?

Infer which was built first.

11. In what parts of the quadrangle are the roads laid out on the rectangular system? Why not elsewhere?

12. What are the occupations of the people in this area?

Answers

EXERCISE XXII

DUNE SAND TOPOGRAPHY

Purpose. To study the topographic features of sand hill regions.

Material. Brown's Creek Sheet, Nebraska.

Suggestions. The topography of northeast two-thirds of the quadrangle is typical of the great sand-hill area of Nebraska and the form of the dunes shown is representative of that in other dune areas, as in Kansas, Northern Indiana, and along the coast of parts of Virginia, Maryland, New Jersey, and Long Island. The lakes shown on this map mark the places where depressions extend below the water table,—the upper limit of the saturated zone of groundwater.

The dunes shown are made up of fine sand which suffers considerable shifting by wind action. Vegetation is not very heavy. Grasses are firmly rooted in the valleys, and more or less so in the hills. The rainfall averages from 15 to 18 inches per year.

In the southwest part of the quadrangle a portion of the North Platte River and valley is shown. Notice that the stream does not here have a braided course.

Studies. 1. In what part of Nebraska is this quadrangle? The greater part of the sand dune area is directly east and north of this.

2. Only what part of this area has been dissected by stream erosion?

3. (a) If the bluffs north of the river were unconsolidated sands, would there be much surface run-off? (b) Then could canyons develop?

4. How are the dunes represented? About what is their general height?

5. Look for depression contours. How deep are some of the depressions? How account for them?

6. What does the scarcity of streams indicate as to texture of the soil?

7. What is the general direction of larger valleys and ridges of dunes?

8. Bearing in mind the influence of vegetation, at what season, summer or winter, would wind work be most effective? Infer the direction of prevailing winds at that season.

10. Account for arrangement of wagon roads.

11. What are the occupations of the people in this region? Is it densely populated? Why?

Answers

EXERCISE XXIII

THE LOESS PLAINS

Purpose. To study the characteristics of the slightly dissected loess plains.

Material. York sheet, Nebraska.

Suggestions. The topography of the York quadrangle is typical of the large area in Nebraska and Kansas known as the Loess Plains. These plains include much of the southern one-half of Nebraska, extending into western Kansas. Along the larger streams they are quite thoroughly dissected so that they present rather hilly topography. In the section of which this is a part, extending from Crete to west of Holdrege, stream erosion has not been very great. This quadrangle is just west of the glaciated area so that the surface is free from deposits of glacial origin. The loess is a fine-grained, silty material usually classified as a wind-blown deposit. It yields a soil of high fertility and suited to a variety of crops. The loess in this region is quite thick, reaching a depth on some of the uplands of from forty to eighty feet.

Studies. 1. In what part of Nebraska is this quadrangle located?

2. What is the general direction of the slope of this region as indicated by stream courses?

3. Is this a region of great or little relief?

4. Describe the general form of the valleys as to whether they are gorge-like, or open with gently sloping sides. About what is the depth of the larger valleys below the bordering uplands?

5. Are the divides sharp and ridgelike or flat-topped? Account for this.

6. How account for the various marsh areas in this quadrangle? Are they generally located on divides or in valleys?

7. Notice the large marsh area south of York. These marshes are known locally as **ponds.** What is the altitude of the marshes? At what altitude is Beaver Creek, just north of there? As erosion progresses how will the little valleys tributary to Beaver Creek change in length? What will then happen to the marsh or pond? Note if same condition is true of other marshes.

8. Does topography seem to exert much control over the location of wagon roads and railroads? Cities?

9. What are the chief occupations of the people in this region? To what class of farm crops is this topography particularly well adapted?

10. Would you call this a young, mature, or old plains topography? Why?

Answers

EXERCISE XXIV

YOUNG GLACIAL TOPOGRAPHY.

Purpose. To study typical surface features of a region showing topography about as left by glacial invasion.

Material. Sun Prairie Sheet, Wisconsin.

Suggestions. The relief of this region is dominated almost wholly by the elliptical hills called drumlins. They are composed of unstratified drift material, chiefly clay, sand and gravel. Drumlins are well developed over a large area in Wisconsin, as well as in Michigan and Minnesota. There are also noted drumlin areas in New York and New England, the eastern part of Massachusetts being especially well known. Bunker's Hill and Breed's Hill are both drumlins.

Studies. 1. In what part of Wisconsin is this quadrangle located? What is its area?

2. About what is the height of the hills?

3. In what directions do the major axes of these hills generally extend? The uniformity noted is characteristic of drumlins.

4. Study the slopes of the drumlins. Do you find any evidence of ravines or small valleys down their sides? Do they seem to have been affected much by erosion? Infer as to whether they have been exposed to erosion a long or short time.

5. What is true of the number of streams in this region? Do they have well-developed tributary streams?

6. Why are the stream courses so crooked?

7. Can you find any instance where the streams cut through the hills?

8. Infer as to whether the streams were developed before or after the hills were formed in this area; i. e., were the stream courses consequent or antecedent to the formation of the drumlins?

9. About what portion of this quadrangle is in marshes and lakes?

10. As the streams become older and more developed will the marsh area become larger or smaller?

11. What seems to control location of wagon roads and railroads? Infer as to leading industrial pursuits in this district.

12. Give a summary of reasons why this quadrangle is said to have a young glacial topography.

Answers

LAND FORMS

EXERCISE XXV

MOUNT SHASTA

Purpose. To study the characteristics of a typical extinct volcano and the glaciers on its upper slopes.

Material. Shasta Special Sheet, California.

Suggestions. One of the best references on this topic is Monograph VIII of Physiography of the United States (American Book Co., Chicago. Price 20c). In it Prof. J. S. Diller says, "Towering more than a mile above its neighbors, perhaps the youngest of the group, Mount Shasta is the last of a long series of volcanoes in the Cascade Range, stretching northward to Mount Rainer in Washington. It is a typical example of a large volcano. Its upbuilding resulted from long continued series of intermittent eruptions. The attack of the weather increased with the height of the mountain, and reached its climax with the decadence of volcanic energy. Mount Shasta is beyond the prime of its life. It is in the decline of its maturity. It has passed from a stage of vigorous growth into one of decadence. During the brief period in which the weather has exercised supreme control, the slopes of Mount Shasta have been deeply cut with canyons, and it is beginning to show clearly the ravages of time. In the course of geologic time it will be swept away, but for ages yet to come it will remain one of the grandest mountains on earth."

Studies. 1. Where is Mount Shasta? What is its altitude?

2. How high is it above the valley in northeast part of quadrangle? How high above the Southern Pacific railroad at Sisson?

3. How are glaciers indicated on the map? How many do you find on Mount Shasta?

4. On which slopes of the mountain are glaciers most numerous? Why? Account for the position of the largest glacier.

5. Note the curve of the blue lines crossing the glaciers. Which part of the glaciers moves most rapidly? Why?

6. Why do so many little streams rise just below Hotlum Glacier? Note if streams head below other glaciers also.

7. What do the areas of brown dots just below the glaciers indicate?

8. Find areas of lava flows. How do contours curve in crossing them? Contrast with valley curves.

9. How high is the lava flow near west margin of quadrangle?

10. Has Mount Shasta been greatly eroded? Give evidence.

11. Do the trails leading to the summit of Mount Shasta follow ridges or valleys?

12. Note the course of the Southern Pacific R. R. Why so many loops?

Answers

LAND FORMS

EXERCISE XXVI

PHYSIOGRAPHIC REGIONS OF THE UNITED STATES

Purpose. To study the different geographic provinces, considering location, structure, and economics.

Material. Map showing Physiographic Regions of the United States. Colored crayons.

Suggestions. The accompanying map outlines the geographic regions in a general way only. It must be kept in mind that in some of the regions there are different provinces, and that geographers are not agreed on the names of the main subdivisions. The names here suggested are deemed logical and are in accord with the general trend of nomenclature.

It is essential that pupils learn the names and locations of these major subdivisions of our country. These represent in general areas of industrial and social unity, while state boundaries do not.

Studies. 1. How many physiographic regions are shown on the map?

2. In which region is your home?

3. How many distinct mountain regions in the United States? Which is the most extensive?

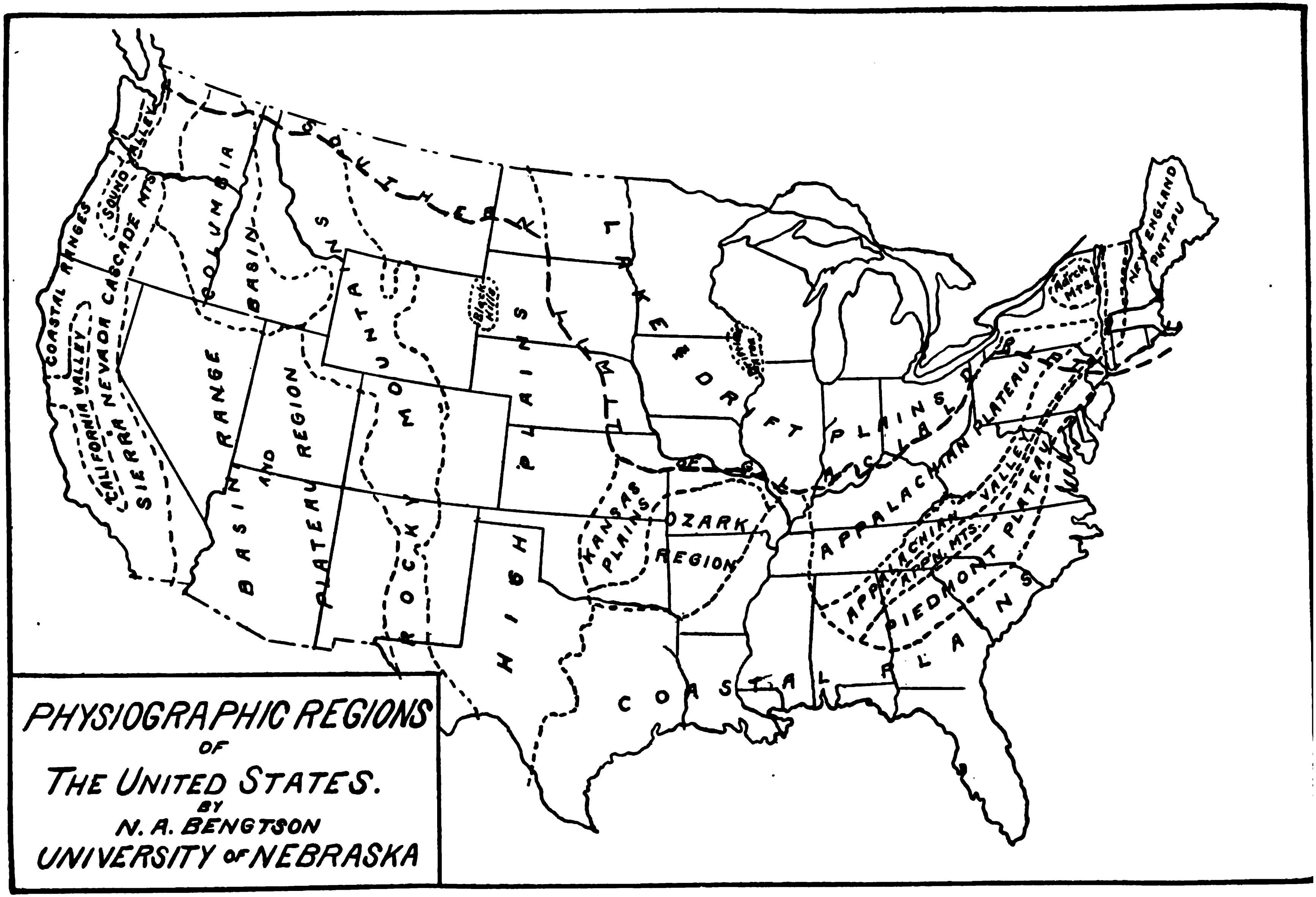
4. How many distinct plains regions in the United States? Name the three largest.

5. To what regions does your state belong?

6. (a) What states are wholly within the Coastal Plains? (b) What states are wholly within the Lake and Drift Plains?

7. Color the map neatly so as to show clearly the different regions.

Answers



PHYSIOGRAPHIC REGIONS
OF
THE UNITED STATES.
BY
N. A. BENGTSON
UNIVERSITY OF NEBRASKA

EXERCISE XXVII

RIVER PROFILES

Purpose. To illustrate graphically the longitudinal characteristics of some of the well-known American rivers.

Material. Profile paper.

Suggestions. Making profiles of streams from following data is fascinating and instructive. If time does not permit plotting all the streams, select those of greatest interest to the class. All classes should plot the Hudson, Niagara, and Mississippi Rivers. In the first work it is best to put but one profile on a sheet. Select scale suited to the size paper and the stream data. To determine scale always consider the **highest** altitudes and **greatest** lengths involved in river to be plotted. To illustrate,—in case of the Mississippi River the length is 2,296 miles and the altitude of source is 1,462 feet. The paper to be used is 24 cm. long x 18 cm. wide. In this case the following scale is found convenient,—horizontal, 1 cm.= 100 miles, vertical 1 cm.=200 feet.

It is generally advisable to begin at the mouth of the stream and locate each point in succession until the source is reached. Then connect these points by a smoothly curved line. Avoid sharp angles.

It is sometimes found interesting to plot in different colors several streams on one sheet, using same scale for all. In this way streams are concisely contrasted as to length and slope.

Directions—Draw profiles of as many rivers from accompanying data as time will permit.

Notes and Drawings.

DATA FOR PROFILES OF RIVERS.

Mississippi River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	0 feet
Mouth of Red River	316 "	7 "
Vicksburg, Miss	487 "	48 "
Memphis, Tenn	862 "	185 "
Columbus, Ky	1,076 "	271 "
Mouth of Missouri River	1,288 "	395 "
Burlington, Iowa	1,492 "	510 "
La Crosse, Wis	1,790 "	628 "
St. Paul, Minn	1,937 "	683 "
Minneapolis, Minn	1,952 "	794 "
Lake Itasca	2,296 "	1,462 "

Missouri River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	395 feet
Nebraska City, Neb	608 "	908 "
Sioux City, Iowa	807 "	1,077 "
Chamberlain, S. D	1,058 "	1,323 "
Fort Benton, Mont	2,074 "	2,565 "
Great Falls, Mont	2,111 "	3,295 "
Three Forks, Mont	2,340 "	4,061 "
Source of Gallatin River	2,428 "	7,000 "

Ohio-Allegheny River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	277 feet
Pittsburgh, Pa	963 "	702 "
Mouth of Red Bank River	1,027 "	821 "
Source	1,300 "	1,700 "

Platte River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	940 feet
Kearney, Neb	221 "	2,200 "
Sterling, Colo	453 "	3,920 "
Denver, Colo	603 "	5,170 "
Platte Canyon, Colo	623 "	5,492 "
South Platte, Colo	632 "	6,085 "
Mouth of Tarryall Creek	670 "	7,500 "
Source	742 "	10,000 "

Colorado River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	0 feet
Grand Wash	600 "	1,000 "
Navajo Creek	905 "	3,222 "
Mouth of Yampa River	1,470 "	5,100 "
Big Sandy River	1,652 "	6,240 "
Source	1,800 "	7,808 "

DATA FOR PROFILES OF RIVERS (Continued)

Columbia-Snake River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	0 feet
Mouth of Snake River	312 "	145 "
Weiser	618 "	2,123 "
Glenns Ferry	792 "	2,500 "
....	914 "	4,190 "
Salt River	1,110 "	5,363 "
Shoshone Lake	1,251 "	7,746 "

Hudson River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	0 feet
Troy	150 "	5 "
Fort Edward R. R. Bridge	190 "	118 "
Secandaga River	216 "	536 "
Schroon River	228 "	594 "
North Creek	248 "	981 "
Tear of Clouds	300 "	4,322 "

Niagara River.

Station—	Distance from Mouth.	Altitude.
Mouth	0 miles	250 feet
Escarpment	7 "	270 "
Whirlpool	11 "	300 "
Below Falls	14 "	360 "
Above Falls	14 "	520 "
Head of Rapids	15 "	550 "
Lake Erie	30 "	570 "

Suggested Scales.

River—	Horizontal Scale.	Vertical Scale.
Mississippi	1 cm. = 100 miles	1 cm. = 200 feet
Missouri	1 " = 100 "	1 " = 500 "
Ohio-Allegheny	1 " = 100 "	1 " = 200 "
Platte	1 " = 50 "	1 " = 600 "
Colorado	1 " = 100 "	1 " = 500 "
Columbia-Snake	1 " = 100 "	1 " = 500 "
Hudson	1 " = 20 "	1 " = 400 "
Niagara	1 " = 2 "	1 " = 100 "

EXERCISE XXVIII

CHANGES OF VOLUMES OF AIR

Purpose. To show the changes of volume due to heating and cooling air.

Material. Lamp. Bottle. One hole stopper. Glass tube. Beaker or tumbler.

Suggestions. For this experiment any kind of a lamp will suffice although a Bunsen flame or alcohol lamp is preferable. Use a small bottle, about a four ounce capacity, with a tight fitting cork. Bore a hole in the cork into which fit closely and seal with wax or paraffine a small glass tube about six inches long. The glass tube should project through the cork into the neck of the bottle and the outer two inches should preferably be bent at about right angles to the longer part of the tube. A beaker or tumbler nearly filled with water completes the necessary equipment.

The experiment should be performed by the students working in groups of three or four. Where laboratory facilities are lacking or supervision impossible, the experiment may be performed by the teacher in the presence of the class, and wrtten up by the pupils as a class exercise.

Studies. With apparatus fitted up as called for above, hold the bottle so that the outer end of the glass tube is in the water in the beaker.

1. What fills the bottle when it is usually spoken of as "empty"?

2. With the outer end of the glass tube under water heat the bottle gently. (a) **Observe** what passes out of the tube. (b) **Infer** the cause. (c) Continue heating for a short time. Is the bottle still full of air? (d) **Infer** whether there is as much air as was there at first. (e) What effect does heating the air have on its volume?

3. Without removing the glass tube from the water allow the bottle to cool slowly. (a) **Observe** what occurs. (b) Infer the cause. (c) Is the bottle now full of air? (d) Is there as much air as there was before the bottle began to cool? (e) What effect does cooling the air have upon its volume?

4. If atmospheric pressure is equal in each case, which will contain the greater quantity (mass), a certain volume of cold air or the same volume of warm air? Which of the two volumes will be the heavier?

5. On a day when the rooms are artificially heated, test the temperature of the air in the upper part of the room and compare with the temperature of air near the floor. Account for condition found. Why not the reverse?

Results

ATMOSPHERE STUDIES

EXERCISE XXIX

ATMOSPHERIC PRESSURE

Purpose. To ascertain whether the atmosphere exerts pressure.

Material. Sheet rubber. Lamp chimney or thistle-tube. Cup and saucer. Blow-pipe. Electric light bulb. Balance.

Suggestions. The first two of the following experiments should be performed by the teacher but the questions are to be answered by the pupils from studies of the phenomena observed. The electric light bulb called for can be one which has been "burnt out" and hence is practically worthless. These can generally be procured free or at trifling cost from the managers of the electric light systems in the various towns.

Experiments. 1. Fill a saucer about two-thirds full of water. Take a piece of paper, crumple it somewhat in the hand, then set it on fire and place on the water surface. Quickly place an inverted cup over it so that the edges of the cup extend below the water surface. (a) **Observe** what happens to the water. (b) Can paper burn without using some air? (c) **Infer** the cause of the water moving up into the cup. (d) In what direction was the pressure exerted?

2. Place an electric light bulb on one pan of a balance and place weights on the other so as to counterbalance the bulb. By means of the blowpipe blow the flame of an alcohol lamp or Bunsen burner against the bulb until a hole is made in it. (a) Is the bulb now exactly counterbalanced? (b) Is it heavier or lighter than before? **Infer** whether or not air has weight. (c) Note the form of the opening in the bulb. Are the edges of the glass bent in or out? What force made the hole in the glass? Why was it necessary to use heat? (d) In what directions was pressure exerted in this case?

3. Tie in loose folds some sheet rubber over the large end of a thistle tube or lamp chimney, being careful to make the rubber covering airtight. Blow into the open end of the tube and **observe** the rubber. Compare the amount of air in the tube now and before. **Infer** why the rubber is pressed outward.

With the same apparatus draw out some of the air and **observe** the rubber. Exhaust more of the air and **observe** again. Compare in both cases the amount of air remaining in the chimney with the amount at first. **Infer** why the rubber was forced inward in both cases and more so in one case than in the other.

4. In a summary statement give proofs of air pressure and the directions in which it is exerted.

Results.

ATMOSPHERE STUDIES

EXERCISE XXX.

THE BAROMETER.

Purpose. To study the principles of the construction and use of the mercury barometer.

Material. Wide mouth bottle. Two hole stopper. Glass tubes. Mercury.

Suggestions. Provide for the first of the following experiments a wide mouth bottle fitted with a cork into which has been bored two holes. Pour water into the bottle until about two-thirds full. Fit a glass tube about 30 inches long **closely** into one of the holes in the stopper, so that its lower end extends nearly to the bottom of the bottle. Through the other hole place a short glass tube bent into a right angle, so that its lower end does **not** touch the water. If difficulty is met with on account of air leakage seal around the tubes with paraffine. The second experiment should be performed by the teacher in the presence of the class. Pupils should take notes on phenomena observed and write their own inferences as called for.

Directions—Exp. 1. Blow gently through the short tube into the bottle. (a) Observe the water in the long tube. (b) Repeat, blowing harder than before. (c) What is true of the condition of the air in the bottle? (d) Blow until the long tube becomes filled with water, then close the upper end of the tube with the finger. Why does not the column fall? (e) Exhaust some of the air. What becomes true of water column then? (f) By what is the weight of water in the closed tube sustained?

*Exp. 2. Fill with mercury a glass tube at least 30 inches long and closed at one end; holding the forefinger close over the open end, invert the tube and plunge the open end under some mercury in an open dish and remove the finger. (a) Why is the mercury column sustained above the level of the water outside? (b) Why did the column fall to some extent and thus not fill the tube? Contrast with water. (c) What is true of the amount of air in the space in the tube above the mercury? (d) Measure the height of the column above the level of the mercury in the dish. Mercury being 13.6 times as heavy as water, what height of water column would be supported by the same atmospheric pressure? (e) How will a high atmospheric pressure affect the height of the mercury column? A low atmospheric pressure? (f) What does a "low" barometer signify as to condition of the atmosphere? A "high" barometer?

*(This experiment should be performed by the teacher.)

Results.

EXERCISE XXXI

USE OF THE BAROMETER

Purpose. To study the construction of the mercury barometer and the significance of barometer readings.

Materials. Mercury barometer.

Suggestions. For this exercise a good mercury barometer is essential. Pupils should be instructed in its use and every pupil should read the instrument and record the data until he has become proficient in taking readings and making his interpretations.

Studies. 1. How long is the closed tube which contains the mercury column?

2. How is the cistern or mercury reservoir provided?

3. As the mercury in the tube rises, does the mercury surface in the cistern rise or fall?

4. What arrangement is provided to adjust the surface of the mercury in the cistern so as to maintain a constant level?

5. If a vernier is provided on your barometer, learn how to use it and why accurate readings can be made with it.

6. Make and record observations as called for in accompanying form.

[Answer when data have been recorded.]

7. How much difference between highest and lowest barometer readings?

8. Is the falling barometer accompanied by warmer or colder weather? What is true of the rising barometer?

9. From data recorded can you see any relation between rising or falling barometer and wind direction?

Answers

BAROMETER READINGS.

Date	Day	Barometer Reading	Change (— or +) in last 24 hrs.	Wind Direction	Temperature

ATMOSPHERE STUDIES

EXERCISE XXXII

CURRENTS IN THE ATMOSPHERE

Purpose. To study some of the causes of air currents and of their directions.

Material. Cigar box. Two lamp chimneys. Candle.

Suggestions. Take an empty cigar box with cover intact and cut two holes, each with a diameter of about half an inch. Seal with paraffine all cracks in the box so that it will be practically air-tight save for the two holes. It is preferable to take out the sides of the box and replace them with pieces of glass of same size because then movements of air currents can be more easily traced. Beside one of the openings place a short lighted candle. Then over each of the openings set a lamp chimney made **air-tight** at the bottom by means of grease or paraffine. One apparatus set up as directed can be seen and studied by the whole class.

Studies. 1. By means of the smoke from a piece of "smudge paper" or an extinguished match test for air currents at the tops of the chimneys. State direction of each.

2. Which chimney contains warm air? Which cold air?

3. Explain why the air goes down one chimney and through the box.

4. Explain the cause of the motion of the air in the heated chimney.

5. What will be true of the temperature of the warmed air after leaving the chimney? Trace its possible course to make a complete round of circulation.

6. On a day when the temperature outside is lower than that within, lower the upper sash of a window and raise the lower sash. Test direction of air currents in each opening.

7. With conditions as stated in previous question, test the air currents in an open door. Do currents move in the same direction in the upper part of the doorway as in the lower? Explain.

8. Let there be in one region of country a warm, moist atmosphere while in an adjoining section it is cold and dry. Trace a complete circulation of air made possible by those conditions.

9. The term **wind** should be used only for air currents near the surface of the earth, and not for ascending or descending currents or for currents in the upper atmosphere. Infer how winds blow with reference to an area of high barometer; low barometer.

10. With air currents established, and independent of temperature and moisture changes, how will upward currents affect the reading of the barometer? What will be the effect of downward currents?

Results

EXERCISE XXXIII

EVAPORATION

Purpose. To study the conditions affecting the rate of evaporation.

Material. Saucer. Glass plates (2). Beakers (2). Small cups (2).

Directions. **Experiment I.** Cover the bottom of a saucer or tin plate with water to a depth of about one-eighth inch. Let stand exposed to the air for a day. Note result.

Experiment II. Put five drops of water on each of two glass plates. Place one on the desk away from any draft of air. Heat the other **gently.** Observe from which the water evaporates the faster. Infer the cause.

Experiment III. Place equal quantities of water in two beakers or small cups. Place them side by side where hey may be left undisturbed for several hours. Cover one with an inverted tumbler, and leave the other open.

(a) What collects on inside of inverted tumbler?
(b) Is the air in the tumbler dry or moist?
(c) From which beaker does evaporation take place the more rapidly?

Experiment IV. Place three drops of water on a glass plate and put in some quiet place away from any draught. On another plate drop the same quantity of water and then place in a strong draught for several minutes. This can be accomplished by either blowing on it or fanning it.

(a) From which does evaporation proceed more rapidly?
(b) Infer another factor in rapidity of evaporation.

Questions

1. From above experiments infer what becomes of water when it evaporates.
2. At what temperatures does vaporization of water occur most rapidly?
3. When do clothes dry most readily, in winter or summer? On a windy or a calm day? On a cloudy day or when it is clear? Give reason in each case.
4. Name some sources whence the supply of moisture in the air is maintained?
5. Summarize the conditions under which vaporization from land and water surfaces will go on most rapidly.

Results

ATMOSPHERE STUDIES

EXERCISE XXXIV

EFFECTS OF EVAPORATION

Purpose. To study some of the effects of evaporation.

Material. Alcohol. Two thermometers. Lamp wick. Cotton or cotton cloth.

Directions. Experiment I. Place one or two drops of alcohol, of about the same temperature as the room, on the back of the hand. Note the sensation while the alcohol is evaporating. Infer the cause.

Experiment II. Hang side by side two thermometers of same size and style, so that they will indicate correctly the temperature of the room. Around the bulb of one of them place a small tuft of dry cotton. After a minute or two note if the reading has been affected thereby. Then place a few drops of alcohol or ether, of the same temperature as the room, on the cotton.

(a) What is the general effect on the thermometer?

(b) Is the change in reading rapid or slow?

(c) How many degrees difference in the reading of the two thermometers could you obtain?

(d) From where does part of the heat absorbed by the alcohol in evaporating come?

Experiment III. Using the same apparatus as in the preceding experiment, put a single drop of water on the cotton over the bulb of one thermometer. As it evaporates note effect on thermometer reading. Why is not the change as marked and rapid as when alcohol or ether was used?

Experiment IV. Construct a wet bulb thermometer by connecting the cotton on the covered bulb with a small vessel of water by means of a short piece of lamp wick. This will replenish the water in the cotton over the bulb as rapidly as it evaporates. Place an ordinary thermometer where it will represent fairly the temperature of the room, and put the wet bulb thermometer near it. After a little while observe the readings of the two instruments.

(a) How much difference is noted?

(b) Let the apparatus remain in place a week or more and observe the temperatures from time to time. Why is the difference in readings not uniform?

(c) When will evaporation be the more rapid, when the air is comparatively dry or moist (humid)?

(d) If the difference in readings between wet bulb and dry bulb thermometers is high does it indicate dry air or moist air?

Summary

(a) What effect does evaporation have upon the temperature of the body or surface from which it takes place?

(b) Is evaporation a warming or cooling process as far as adjacent bodies are concerned?

Results

ATMOSPHERE STUDIES

EXERCISE XXXV

CONDENSATION OF WATER VAPOR

Purpose. To study the condensation of water vapor and its geographic relations.

Material. Flask. One hole stopper. Glass tube. Tin cup. Thermometer. Ice. Salt.

Experiment I. Boil some water in a flask fitted with a one-hole stopper through which has been placed a glass tube two or three inches long and of about one-fourth inch diameter.

(a) What is the color of the vapor or steam in the flask?

(b) When the water boils briskly can you see any vapor or steam just at the mouth of the glass tube?

(c) Infer as to the color of steam.

(d) Observe what forms just beyond the mouth of the glass tube. Explain.

(e) Hold a cool object, such as a piece of iron or a glass plate, in the steam near the mouth of the glass tube. What collects on it? Why?

Experiment II. Thoroughly dry the outside of a tin cup and half fill it with water. Put in some ice or snow and stir with a thermometer.

(a) At about what temperature is the cup when moisture begins to collect on the outside?

(b) Infer the significance of "dew point."

(c) Where does the moisture come from?

(d) What caused the moisture to collect on the sides of the cup? Why was no moisture apparent at first?

Experiment III. Fill a tin cup whose outside is dry, with finely cracked ice or snow, mixed with about one-third its volume of salt. Stir carefully with a thermometer.

(a) At what temperature did frost begin to form on the outside of the cup?

(b) Did dew form before the frost appeared?

(c) With the atmosphere very dry, would dew form before frost? Why?

Summary

1. What is the distinction between evaporation and condensation?
2. What causes the appearance of a cloud at the month of a tea kettle of boiling water and its disappearance a little farther outward?
3. Account for the "sweating" of water coolers and pump heads.
4. Explain why fogs and clouds are often characteristic of mountain slopes.
5. How account for the fogs characteristic off the coasts of Labrador and Newfoundland?
6. Why is it that we can generally "see our breath" on cold days and not on warm days?
7. Explain why in some regions of earth a sudden and extreme fall of temperature may not cause any form of precipitation.
8. What is true of the fitness for habitation of a region where atmospheric moisture is seldom condensed?

Results

Table Showing Some

CLIMATIC FACTORS OF THE UNITED STATES.

Taken from the records of the Stations of the

UNITED STATES WEATHER BUREAU

Station	Average Jan. Temp.	Average July Temp.	Average Annual Temp	Annual Pressure	Annual Rainfall
Abilene, Tex	43	82	63	29.97	25
Albany, N. Y.	23	72	48	30.03	36
Alpena, Mich.	19	66	42	30.01	33
Amarillo, Tex.	34	76	55	29.95	23
Atlanta, Ga.	42	78	61	30.07	49
Atlantic City, N. J	32	72	52	30.04	41
Augusta, Ga.	46	80	64	30.07	48
Baker City, Ore	24	65	45	30.05	13
Baltimore, Md.	33	77	55	30.05	43
Bismark, N. D.	7	70	40	30.00	18
Block Island, R. I.	31	68	50	30.02	44
Boise, Idaho	29	73	51	30.04	13
Boston, Mass	27	71	49	30.01	43
Buffalo, N. Y.	25	70	47	30.02	37
Cairo, Ill.	35	79	58	30.05	42
Cape May, N. J.	34	73	54	30.05	41
Carson City, Nev.	33	68	49	29.98	11
Charleston, S. C.	49	81	66	30.07	52
Charlotte, N. C.	40	79	60	30.07	49
Chattanooga, Tenn	41	78	60	30.07	51
Cheyenne, Wyo	26	67	45	29.96	14
Chicago, Ill.	24	72	48	30.03	33
Cincinnati, O.	32	78	55	30.03	38
Cleveland, O.	26	72	49	30.04	35
Columbia, Mo.	27	77	54	30.03	37
Columbus, O.	29	75	52	30.05	37
Concordia, Kan.	24	78	53	30.01	27
Corpus Christi, Tex	54	83	70	29.99	27
Davenport, Iowa	21	75	49	30.03	33
Denver, Colo.	29	72	50	29.95	14
Des Moines, Ia.	20	76	49	30.02	32
Detroit, Mich.	24	72	48	30.03	32
Dodge City, Kan	27	78	53	29.98	21
Dubuque, Iowa	18	75	48	30.03	34
Duluth, Minn.	10	66	39	30.01	30
Eastport, Maine	20	60	41	29.97	43
El Paso, Texas	44	81	63	29.89	10
Erie, Pa.	27	72	49	30.03	39
Escanaba, Mich.	14	67	41	30.01	32
Eureka, Cal.	47	55	51	30.07	46
Fort Smith, Ark	38	81	61	30.03	41
Fresno, Cal.	45	82	63	29.97	10
Galveston, Tex.	53	83	69	30.02	47

Station	Average Jan. Temp.	Average July Temp.	Average Annual Temp.	Annual Pressure	Annual Rainfall
Grand Haven, Mich	25	70	47	30.02	31
Green Bay, Wis	5	70	43	30.01	31
Hannibal, Mo	27	77	53	30.03	34
Harrisburg, Pa	29	75	52	30.05	37
Hatteras, N. C.	46	79	62	30.05	61
Havre, Mont	14	68	42	29.97	14
Helena, Mont	20	67	43	30.01	13
Huron, So. Dak	10	72	42	30.01	21
Indianapolis, Ind	28	76	53	30.05	41
Jacksonville, Fla	54	81	68	30.06	53
Jupiter, Fla	64	81	74	30.03	60
Kansas City, Mo	26	78	53	30.02	37
Key West, Fla	69	84	77	30.02	39
Knoxville, Tenn	38	76	57	30.07	49
La Crosse, Wis	15	73	46	30.02	31
Lander, Wyo	17	68	42	29.99	14
Lewiston, Idaho	35	74	53	30.04	13
Lincoln, Neb	21	76	50	30.01	28
Little Rock, Ark	41	81	62	30.04	50
Los Angeles, Cal	54	70	62	29.97	16
Louisville, Ky	34	79	57	30.06	44
Lynchburg, Va	36	77	56	30.07	43
Marquette, Mich	16	65	41	30.00	33
Memphis, Tenn.	40	81	61	30.05	50
Miles City, Mont	15	73	44	29.99	13
Milwaukee, Wis	20	70	45	30.02	31
Mobile, Ala	50	81	66	30.05	62
Montgomery, Ala	48	81	65	30.06	51
Moorhead, Minn	3	69	38	30.01	25
New Haven, Conn	27	72	50	30.03	47
New Orleans, La	53	81	68	30.03	57
New York, N. Y	30	74	52	30.04	45
Norfolk, Va	40	78	59	30.05	50
Northfield, Vt	15	67	41	30.01	34
North Platte, Neb	21	74	48	29.99	19
Oklahoma City, Okla	35	80	59	30.00	32
Omaha, Neb	21	77	50	30.02	31
Oswego, N. Y	24	70	47	30.02	36
Pensacola, Fla	52	81	68	30.05	56
Philadelphia, Pa	32	76	54	30.04	41
Phoenix, Ariz	50	90	69	29.88	8
Pierre, So. Dak	18	75	46	30.00	17
Pittsburgh, Pa	31	75	53	30.05	36
Port Huron, Mich	22	69	45	30.02	31
Portland, Me.	22	68	45	30.00	43
Portland, Ore	39	66	52	30.06	45
Pueblo, Colo	29	74	51	29.94	12
Rapid City, So. Dak	22	70	45	29.98	19
Red Bluff, Cal	45	82	63	30.02	25
Roseburg, Ore	41	66	53	30.06	34
St. Louis, Mo	31	79	56	30.04	37
St. Paul, Minn	12	72	44	30.01	29

Station	Average Jan. Temp.	Average July Temp.	Average Annual Temp.	Annual Pressure	Annual Rainfall
Salt Lake City, Utah	29	76	52	29.98	16
San Antonio, Tex	51	82	68	29.99	27
San Diego, Cal.	54	67	61	29.98	10
San Francisco, Cal.	50	57	55	30.03	22
Santa Fe, N. M	29	69	49	29.91	14
Sault Ste. Marie, Mich	13	62	38	30.00	31
Savannah, Ga.	50	81	66	30.06	50
Seattle, Wash.	39	63	51	30.03	37
Shreveport, La.	46	82	65	30.03	46
Sioux City, Ia.	16	74	47	30.02	26
Spokane, Wash.	27	69	48	30.02	19
Springfield, Ill.	26	76	52	30.04	37
Springfield, Mo.	31	76	55	30.03	45
Toledo, Ohio	26	74	50	30.03	31
Valentine, Neb.	8	73	46	30.00	22
Vicksburg, Miss.	47	80	65	30.05	54
Walla Walla, Wash	33	74	53	30.04	18
Washington, D. C	33	77	55	30.06	44
Wichita, Kan.	30	79	56	30.01	31
Williston, N. D	7	69	39	29.99	15
Wilmington, N. C	46	79	62	30.06	51
Winnemucca, Nev.	29	72	49	30.02	8
Yankton, S. D	16	75	47	30.02	25
Yuma, Ariz	55	91	72	29.88	3

ATMOSPHERE STUDIES

EXERCISE XXXVI

ISOTHERMS

Purpose. To study the significance and plan of mapping of isotherms.

Material. Blank weather maps.

Suggestions and Directions. In the first three columns of the accompanying table are given the average January, July, and annual temperatures as recorded at the different weather bureau stations of the United States. For this exercise use the data given in the third column, "average annual temperature." Using a fine pointed pen or pencil, insert the proper figures upon a blank weather map as near as possible to the circles representing the towns. In the eastern part of the United States great care must be used to select the proper circles. Using a sharp pencil, first draw the isotherm of 40 degrees. Begin a little north of Eastport, Maine, and draw westward leaving north of the line all places having a temperature of less than 40 degrees, and south of the line all places whose temperature is above 40 degrees. The line, if correctly drawn will pass thru Sault Ste. Marie and Bismark and into Canada, a little east of Havre, Montana. At each extremity of the line write its value, 40 degrees.

Next draw the 50 degrees isotherm. Begin at Block Island and draw toward the west using same precautions as to the location of the line as observed for 40 degree isotherm. Care must be used in drawing the line in Oregon and Washington. The 50 degree isotherm passes to the south and west of Baker City nearly to Portland, then curves back eastward, passes south of Walla Walla, turns north and passes east of Lewiston, then turns, passing westward south of Spokane, and terminates at the Coast in the vicinity of Blaine. Mark at its extremities the value of the isotherm, 50 degrees.

Beginning at the Atlantic Coast between Capes Henry and Hatteras draw the 60 degree isotherm. The 70 degree isotherm should be in two parts, one in the Gulf Coast country, terminating in Mexico and the Atlantic Ocean, the other a curve enclosing Yuma, and Phoenix, terminaing in Mexico west of El Paso.

After the map has been criticized by the instructor, trace all the isotherms plainly in ink. You have now a correct normal annual temperature chart of the United States.

Notes and Drawings

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APPENDIX J

ATMOSPHERE STUDIES

EXERCISE XXXVII

JANUARY AND JULY ISOTHERMS

Purpose. To study the range of temperature as shown by isotherms indicating mean seasonal extremes.

Material. Blank weather maps.

Directions. A. From the first column of the table of Climatic Factors of the United States, obtain the data showing average (mean) January temperatures of the different weather bureau stations. As in the previous exercise insert the proper figures upon a blank weather map as near as possible to the circles representing the towns. Draw carefully the isotherms showing 10, 20, 30, 40, 50, and 60 degrees.

1. Where isotherms bend to the south, does it indicate that that region is colder or warmer than adjacent regions in the same latitude? Take actual readings.
2. What is indicated where isotherms bend to the north?
3. Where is the coldest part of the United States in January? The warmest part?
4. Which has the lower winter temperature, northern Montana or northern Minnesota?
5. Contrast the temperature conditions of the Atlantic and Pacific Coasts.
6. How account for the marked difference in temperature between Walla Walla and Baker City? Which is the more favorably situated to receive the benefit of oceanic influence?

B. Using the data given in the second column make an isothermal chart showing July temperatures. This chart together with the two preceding ones should be made with care and bound in such a way that they will be preserved. The data they contain is reliable, having been gathered from the records of the Weather Bureau, carefully kept for a long period of years.

1. Where is the region of maximum July temperature? Minimum?
2. Contrast Pacific Coast temperatures with those in some latitude farther inland.
3. In the same manner contrast Atlantic coast and inland temperatures.
4. From a study of the January and July maps determine (a) the region of highest annual range of temperature; (b) the region of lowest annual range.

Notes and Drawings

EXERCISE XXXVIII

ISOBARS

Purpose. (a) To study the significance of isobars.

(b) To make a map of the United States showing mean annual pressure as corrected to sea level plane.

Material. Blank weather maps.

Directions. The average annual pressures, corrected to sea-level reading, for the different stations in the United States are given in the fourth column in the table of Climatic Factors. With a fine pointed pen or pencil copy these figures on a blank weather map as near as possible to the circles representing the proper towns.

Following same method as was used in mapping isotherms draw the isobars showing pressures of 29.85, 29.90, 29.95, 30.00 and 30.05 inches respectively. These lines properly drawn will give a very accurate mean annual pressure map of the United States.

1. Where are the areas of maximum pressure? Minimum pressure?
2. Compare pressure conditions of the Atlantic and Pacific coasts.
3. Compare pressure conditions of the central states with those of the mountain states.

Notes and Drawings

ATMOSPHERE STUDIES

EXERCISE XXXIX

THE WEATHER MAP

Purpose. To study the daily weather map and the significance of the data used as the basis for forecasts.

Material. Daily weather map (one for each pupil).

Suggestions. The questions for this study are so constructed that they will apply to any daily weather map. While it is not necessary that all the pupils be supplied with the same map, it is highly desirable that they should be. In that way uniformity can be secured in the discussion and any tendency to confusion is avoided. Sufficient copies of the map for any day can generally be secured by addressing the director of the nearest weather bureau station, or by reference to the daily papers of any date.

Directions. 1. By what government department and bureau is the weather map published?

2. On what date was your map published? In what city?
3. At what hour of the day were the observations made?
4. Are the observations taken at the same time all over the United States? Why?
5. Find the following symbols and explain the significance of each.
   (a) Continuous black lines.
   (b) Dotted black lines.
   (c) Arrows.
   (d) Circles.
6. What is meant by "high"? "Low"? State pressure noted for an area of each on your map.
7. Study the general wind directions in areas of highs and lows. Do the winds blow toward or away from the "lows"? "Highs"?
8. On the map find the regions having (a) highest temperature; (b) lowest temperature; (c) highest pressure; (d) lowest pressure.
9. Describe weather conditions at (a) New York City; (b) Chicago; (c) Denver; (d) Seattle; (e) Los Angeles; (f) your home town.

Notes and Drawings

EXERCISE XL

WINDS IN CYCLONES AND ANTI-CYCLONES

Purpose. To study wind directions in different portions of areas of low and high pressure.

Material. Several daily weather maps. Tracing paper.

Suggestions. For this exercise it will be of advantage to have several sets of weather maps, each a series, for six or seven consecutive days. For tracing paper, transparency is essential. Firm tissue paper can be used fairly well if no regular tracing paper is available.

Directions. Draw a circle with a radius of 1.5 inches on a piece of tracing paper. Using same center, draw another circle with a radius of 2.5 inches. Print the word **Low** distinctly in the center of the circles. Draw a vertical line thru the center and mark its upper end **north** and its lower end **south.** Draw another line horizontally thru the center and mark its right end **east** and left end **west.** The circles have thus been divided into four equal parts called **quadrants.**

Place the tracing paper so that the center of the circles will be over the **low** of a weather map. Trace all arrows indicating wind direction which your paper covers.

Place the same paper over the **low** in another map being careful to center the paper as before and to keep the directions correct. Trace the arrows indicating wind direction. Repeat until you have used five or six maps.

1. Are wind directions, in general, away from or toward the **low?**
2. Compare regularity of arrangement of wind directions in inner circle with that in outer circle.
3. What is the general wind direction prevalent in each quadrant?
4. If a southeast wind is blowing over a particular locality, in which direction from it is there very likely a **low?** What if a northwest wind? Southwest? Northwest?

Prepare tracing paper as before and repeat experiment using **highs** instead of **lows.**

1. Constrast general wind directions in an area of high pressure with those in an area of low pressure.
2. What are the general wind directions in the northeast quadrant of an anticyclone? In the southeast quadrant?
3. With a northwest wind blowing at any place, in what direction from it is there likely to be a center of high pressure.

Notes and Drawings

ATMOSPHERE STUDIES

EXERCISE XLI

TEMPERATURES IN CYCLONES AND ANTICYCLONES

Purpose. To study the temperature conditions characteristic of areas of low and high pressure.

Materials. Tracing paper. Daily weather maps.

Suggestions. Tracing paper should be prepared as in Exercise XL. The same series of weather maps can be used, and if possible it is preferable for each student to study the same maps he used in the preceding exercise.

Directions. Place the sheet of tracing paper so that the center of the circles is directly over a **Low.** Then record temperatures found in each quadrant.

1. In which quadrant is the highest temperature? In which the lowest?
2. How do the isotherms bend in passing thru an area of low pressure?
3. In general is the approach of a cyclone marked by higher or lower temperature?

Repeat as outlined above using other maps having well-developed lows. Note if the same conditions will in general hold true.

Prepare another sheet of tracing paper as before and place over an area of high pressure. Note temperatures prevalent in each quadrant. Repeat, using in turn several other maps.

1. In which quadrant is the highest temperature? In which the lowest?

How do the isotherms bend in passing thru an area of high pressure?

3. In general what change of temperature marks the approach of an anticyclone?

These conditions are generally best brought out during the winter months, and hence maps issued during that season are preferable for this exercise.

Notes and Drawings

ATMOSPHERE STUDIES

EXERCISE XLII

PRECIPITATION

Purpose. To study the distribution of rainfall in the United States.

Material. Blank weather maps.

Directions. In the column headed "Annual Rainfall" on the table of Climatic Factors, the average annual rainfall for each of the Weather Bureau stations is given. These averages are compiled from all data available and in most cases represent a long term of years and hence may be considered truly representative of rainfall conditions in the United States.

Using the data referred to, write the rainfall of each station as near the proper circle as possible. Beginning along the east coast of the United States draw a line showing region of 60 inches rainfall. This will be a short line a little west of Hatteras, N. C., terminating in the Atlantic Ocean just east of Cape Henry and Wilmington. Write the value of the line, 60 in., at each extremity. Another 60 inch line will pass thru Jupiter and the southeast point of Florida. Another tongue-shaped curve for 60 in. rainfall will be found enclosing Mobile, Ala., with its extremities in the Gulf of Mexico. Next plot the line for rainfall of 50 inches. Begin at Cape Henry, then on thru Charleston, Savannah, near Thomasville, a little east of Montgomery, north around Chattanooga, thru Memphis, Little Rock and then south to Gulf of Mexico. Plot in a similar manner the lines for 40, 30, 20, and 10 inches and then along the western portion the increasing rainfall shown by 20, 30, and 40 inch lines. Choose some system of coloring or shading so as to leave areas of less than 10 inches rainfall lightest and gradually deepen color or shading so that regions of heaviest rainfall will be shown darkest. This will give a valuable rainfall chart of the United States. Preserve it.

1. What districts of the United States have rainfall of more than 50 inches?
2. Where is the driest part of the United States? Try to account for the low rainfall of this region.
3. About what is the rainfall in the area known as the Corn Belt?
4. What part of Nebraska has a rainfall of less than 20 inches?
5. How account for the high rainfall along the coast of Washington and Oregon?
6. How much of the United States has a rainfall of less than 20 inches?

Answers

ATMOSPHERE STUDIES

EXERCISE XLIII

RAINFALL IN CYCLONES AND ANTICYCLONES

Purpose. To study effects of areas of low and high pressure upon precipitation.

Material. Current weather maps. Tracing paper.

Directions. Draw a circle with a radius of 1.5 inches on a sheet of tracing paper. Using the same center, draw another circle with a radius of 2.5 inches. Print the word **Low** distinctly in the center of the circle. Draw a vertical line thru the center and mark its upper end **north** and its lower end **south.** Draw another line horizontally through the center and mark its right end **east** and left end **west.** By drawing these lines at right angles to each other the circles have been divided into **quadrants.**

Placing the tracing paper so that the center of the circles will be over **low** of a weather map. Trace all circles which indicate the condition of the sky in the area included within the large circle.

Place the same paper over the **low** in another map being careful to center the paper as before and to keep the directions correct. Trace as before all circles indicating state of sky. Repeat until you have used five or six maps.

Prepare another sheet of tracing paper in like manner and repeat above experiment using "highs" instead of "lows."

Questions

1. From data gathered, in what part of an area of low pressure is precipitation most likely to occur?
2. In a "low" where is cloudiness the more pronounced, near the center or around the margins? What is true for a "high"?
3. Summarize what will probably be true of wind direction, relative temperature of the atmosphere, and appearance of the sky; (1) as the advancing eastern edge of a "low" comes over a region; (2) when such "low" is central over a region; (3) as its center passes and the western portion of the "low" prevails.
4. With the approach of a "high" may we usually expect increased cloudiness, or clearing skies?
5. With the approach of a "low" what may be expected as to state of sky?
6. Recall the general wind direction which indicates approach of a "low," or a "high."

Answers

EXERCISE XLIV

MOVEMENTS OF CYCLONES

Purpose. To study approximate rate and general direction of movement of areas of low pressure.

Material. Series of daily weather maps, each for from four to six consecutive days.

Directions and Suggestions. Study a series of weather maps to ascertain the general direction in which the cyclones move so that you will know about where to look for any particular "low" on days following its first appearance.

Choose as the beginning of a series a map having a well-defined "low" somewhere in the western part of the United States.

On a blank weather map place a small circle to mark the position of the center of the "low." Write in the circle the date of the weather map. On the same blank map mark with a circle, properly dated, the position of the "low" the succeeding day. Connect the two circles by a series of arrows. Repeat for succeeding days until the cyclone runs out or until the series is exhausted.

Repeat experiment for several other cyclonic storms.

Use scale of miles to find rate of movement per day of the different storms.

Questions

1. In what part of the United States do the cyclonic storms first appear?
2. In what general direction do cyclones travel? (b) What is their usual direction east of the Mississippi River?
3. (a) In about how many days do the cyclones cross the United States? (b) About how many miles do they travel in one day (24 hours)?
4. Note from the maps studied the general direction and rate of movement of areas of high pressure.
5. In general what kind of weather accompanies the cyclone? The anticyclone?
6. Summarize the factors that should be considered in making weather forecasts.

Answers

EXERCISE XLV

WEATHER FORECASTING

Purpose. To study the plans and problems of weather forecasting.

Material. Daily weather maps.

Suggestions. Cut the lower part of the sheets from a number of weather maps so that the forecast will be removed in each case from the map upon which it was based. Then place date of issue plainly upon the part bearing the map, so that forecasts can later be connected to their proper maps.

The maps published in the daily papers may be used instead of station maps. If so, care must be taken to use successive issues and to save the published forecast for each.

Directions. From a weather map, severed from the forecast as directed, determine the conditions of the weather existing in your locality at the time of issue. Notice all the essential factors such as direction of wind, air pressure, state of sky, temperature, and location and intensity of "highs" and "lows." Tabulate as follows:

1. Temperature .... degrees.
2. Barometric pressure .... inches.
3. Wind direction...
4. State of sky ....

After having made a careful study of all conditions involved, make a forecast of the weather as you believe it will be in your locality twenty-four hours later, and record—

1. Temperature .... degrees.
2. Barometric pressure... inches.
3. Wind direction...
4. State of sky...

When you have made your forecast procure from instructor the forecast as prepared by the weather bureau and also the map for the succeeding day.

1. In what respects did your forecast prove accurate? Where did it fail?
2. Where your forecasts failed state the cause of error.

Repeat above experiment for several other maps, and note if your forecasts improve in accuracy.

Answers

EXERCISE XLVI

WEATHERING

Purpose. To study in the field the forces and effects of weathering.

Suggestions. In suggesting field studies it must be borne in mind that local conditions vary widely and hence no detailed outline can be made to serve all localities. The teacher must first study the geography of her environment, and then select the phases best suited for field studies. The work must be carefully planned and outlined for every study. Pupils should know before starting on an excursion just what is to be looked for, and have some kind of an outline or list of questions to use as a guide. Each trip or excursion should have a particular line of study in view and this should be adhered to very closely.

Directions. A. At any place where rock outcrops, as in a quarry or ravine, look at the base of the ledges for small amounts of soil.

1. How does the color compare with that of the rock?
2. Are there any small pieces or fragments of rock among the debris at the base of the ledge? Are they angular or rounded?
3. Has the ledge had anything to do in producing the soil?
4. Break off parts of the ledge with a hammer. How does the color of the interior of the rock differ from that of surface long exposed.

B. Examine buildings, foundations, stone walls, or cemeteries for evidences of weathering.

1. Can you find any differences between weathered and freshly exposed surfaces?
2. What are some of the agencies which may have been at work to produce these changes?
3. If a visit is made to a cemetery, look for marble monuments put up a number of years ago. Is the polish as perfect as of those erected recently? Are the corners still very sharp? Study the lettering or other carving. Is it as distinct and clear cut as ever? Have any of the monuments suffered any change of color? Note the bases of different monuments. Of what kind of rock are they? Have they weathered to any appreciable extent? Why should the base be of a very durable rock? Study monuments made of sandstone or granite in the same way.
4. What kinds of rocks, of those studied, weather most rapidly?
5. Does weathering take place evenly in all parts of the exposed surface of the same rock?
6. Break a pebble, such as may be picked up in the field or elsewhere where it has been exposed for some time. Why is the interior of a different color from the exterior?
7. Does weathering take place most rapidly above ground, in upper part of ground, or deep below the surface? Observe stone walls, fence posts, tree stumps, etc., for evidence.
8. What influences assist in rock weathering?

Answers

FIELD STUDIES

EXERCISE XLVII

SOME EFFECTS OF SURFACE RUN-OFF

Purpose. To study some of the first effects of running water.

Directions. Study the school grounds or any available field or hillside, preferably soon after a rain has fallen. The place of study should have some slope, part of it bare of vegetation and part covered with grass or other vegetation.

1. How is the water carried off on the surface of the earth?
2. Note in the present surface any cuts or small channels found. What agencies might have produced such features? What proofs can you give as to their origin?
3. Observe carefully the courses taken by the running water. What determines the location of these courses?
4. Why are some cuts larger than others? Will the smaller cuts continue to grow?
5. Find a place where the headwaters of one stream have been cut into, or stolen, by another. How does this affect the growth of the two streams involved?
6. Find some small drainage system where the headwaters of all the tributaries can be observed. Trace the boundaries of this area. Call such a region a **catchment area.**
7. Observe the work of the stream in its steep upper course. How does it differ from the work done in its lower course where the grade is very gentle?
8. If possible find a place where the water flows from the bare slope or ploughed ground onto grass-covered ground. Contrast work done. Explain.
9. Observe hard, packed ground and loose soil. From which is run-off greatest? In order to lessen the erosion should soil be looseor compact?
10. What is the effect of removal of material from this slope? If continued how will it affect soil fertility?
11. When is the work of run-off water greatest?
12. Enumerate the factors upon which erosion depends, as studied in this exercise.
13. In what way may the evil effects of erosion be lessened?
14. Look for illustrations of channel, bar, cut-bank, tributary, falls, rapids, gorge, wide valley, slope, divide, flood plain, alluvial fan, terrace.
15. Summarize the results of your observations, stating (1) what you think was true of the original slope of this surface; (2) its appearance now, and the causes of the change.

Answers and Notes.

FIELD STUDIES

EXERCISE XLVIII

A SMALL STREAM

Purpose. To study the characteristics of river action as exemplified by a small stream.

Directions. 1. Study the current of a small stream. On which side of a curve, the concave or convex, is the stronger current?

2. Which of the banks is the steeper? Why?

3. Find other curves or meanders of the stream and note if same conditions hold true.

4. Where the stream makes a prominent curve which bank is being eroded? Which is being built up? Describe the appearance of each.

5. Where the stream is meandering what is true of its velocity as compared with that of its straighter stretches?

6. Find, if possible, a place where the stream is actively cutting down, **degrading,** its bed. Is its velocity comparatively swift or sluggish? Is its course straight or meandering?

7. Does the stream have a floodplain, or a stretch of so-called bottom-land? Of what is it composed? Describe its topography. Is the material of the floodplain stratified or unassorted? Is the floodplain considered to have greater or less value than the adjacent upland? Can you find any evidence of overflow? In general, are floodplains considered of great or little value? Upon what factors does the value of a floodplain depend? Name some of the important floodplains of the United States?

8. Look for small rapids in the stream. By what are they caused? Above the rapids is the water quiet or turbulent?

9. Above the rapids or waterfalls what determines the depth to which the stream may cut its channel? This is known as a local base level. What is the final base level for any particular stream?

10. What evidences of higher stages of river may be found?

11. Is the stream actually carrying sediment? Take small bottle full of the water and let stand quietly for a couple of hours. Did any sediment settle to the bottom? Take a small portion of the clear water from the bottle in an evaporating dish and evaporate to dryness. What remains in the dish? From whence did it come?

12. Look for examples of the following and if found give location and sketch or describe: (a) A place where the stream has cut thru a neck or curve. (b) A sediment island. (c) Undercutting of rock or soil. (d) Unequal erosion due to differences in hardness of rock.

13. How is the river valley widened?

14. If present activities continue, how will the land ultimately be changed?

15. After a heavy rain note small gullies for examples of erosion. Also look for and note places of deposition. What causes a stream to deposit its load? Find specific illustrations.

Answers and Notes

FIELD STUDIES

EXERCISE XLIX

SOILS

Purpose. To study in the field and laboratory some of the facts and principles pertaining to the origin of soils.

Directions. 1. Look along rock exposures or foundations of buildings for evidences of crumbling rock? What causes the decay? What term is given to the product of this decomposition?

2. Examine the bank or sides of any freshly made excavation or cut. How does the color of the material in the upper part of the cut differ from that in the lower? Look for roots of trees and of other forms of vegetation. What work are they doing? How do they aid in making soil?

3. Examine the material just below the leaves in the woods or the sod or plant refuse in the field. What is the color? Describe the texture. What is its origin?

4. Take samples of the soil from the upper slopes of a fairly steep hill and from its base. Compare the two as to color, texture and composition. Which would be considered the richer soil? What has caused the difference?

5. Collect samples of as many kinds of soil as possible in your vicinity. Describe each as follows:

(a) General color.

(b) Texture, whether uniform or assorted. Take about a teaspoonful of soil in a test tube three-fourths full of water. Shake thoroughly and let stand. After the soil has settled to the bottom of the tube describe the different layers noted. How long did it take in each case for the water to become clear?

(c) Constituent particles. Spread out a small portion of the dry soil on a glass plate and examine carefully with a magnifier. What minerals can you recognize? What percentage seems to be sand? Clay? Humus?

(d) Fill a test tube two-thirds full of the dry soil. Pack well. Then fill tube with water and note the time necessary for the moisture to penetrate to the bottom of the test tube.

6. As far as possible for differences in the soils of your neighborhood.

7. Where are the soils of greatest value in your vicinity? What makes them so?

8. Specify the crops considered best adapted to the different soils of your locality.

Answers and Notes

RECORD OF WEATHER OBSERVATIONS

Date	Day	Temperature	Direction of Wind	Velocity of Wind	Percent of Sky Covered by Clouds	Barometer	Form of Precipitation	Amount of Precipitation	Remarks
Average 1st Week...									
2nd Week...									
3rd Week...									
4th Week...									
Average for Month									

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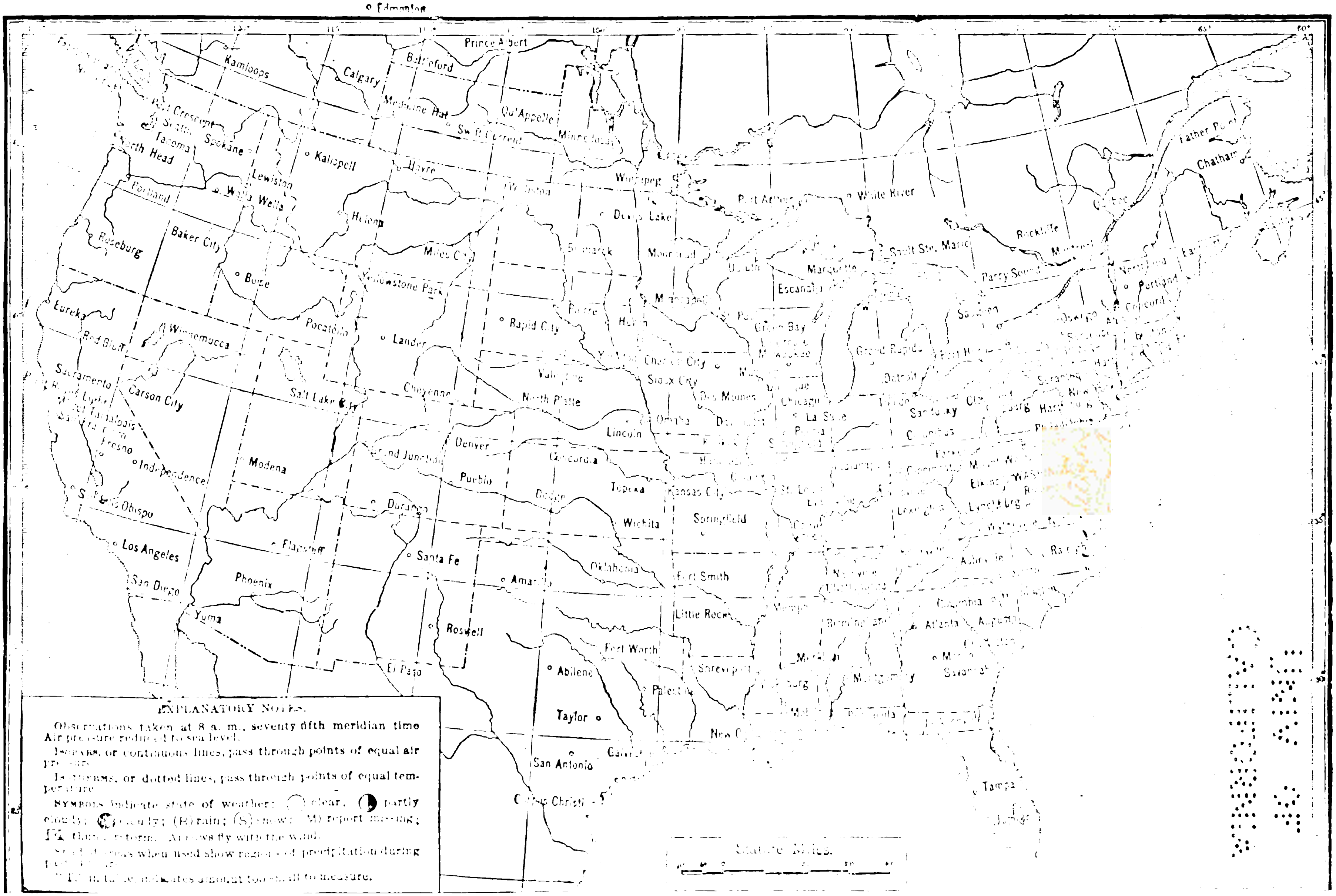

EXPLANATORY NOTES.

Observations taken at 8 a. m., seventy fifth meridian time Air pressure reduced to sea level.

ISOBARS, or continuous lines, pass through points of equal air pressure.

ISOTHERMS, or dotted lines, pass through points of equal temperature.

SYMBOLS indicate state of weather: ○ clear, ◑ partly cloudy; ● cloudy; (R) rain; (S) snow; (M) report missing; [illegible] thunderstorm. Arrows fly with the wind.

Shaded areas when used show regions of precipitation during [illegible]

"T" in table indicates amount too small to measure.

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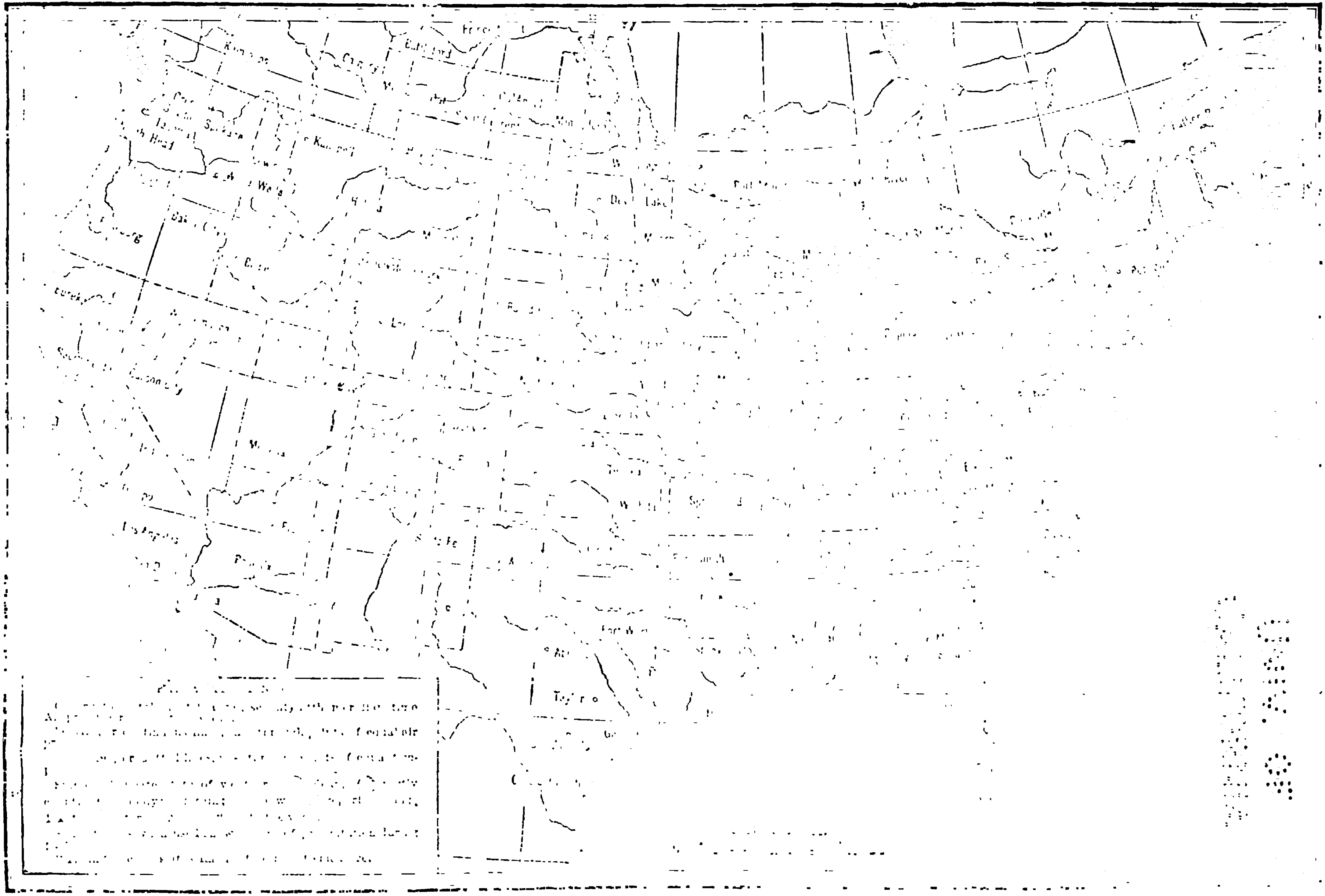

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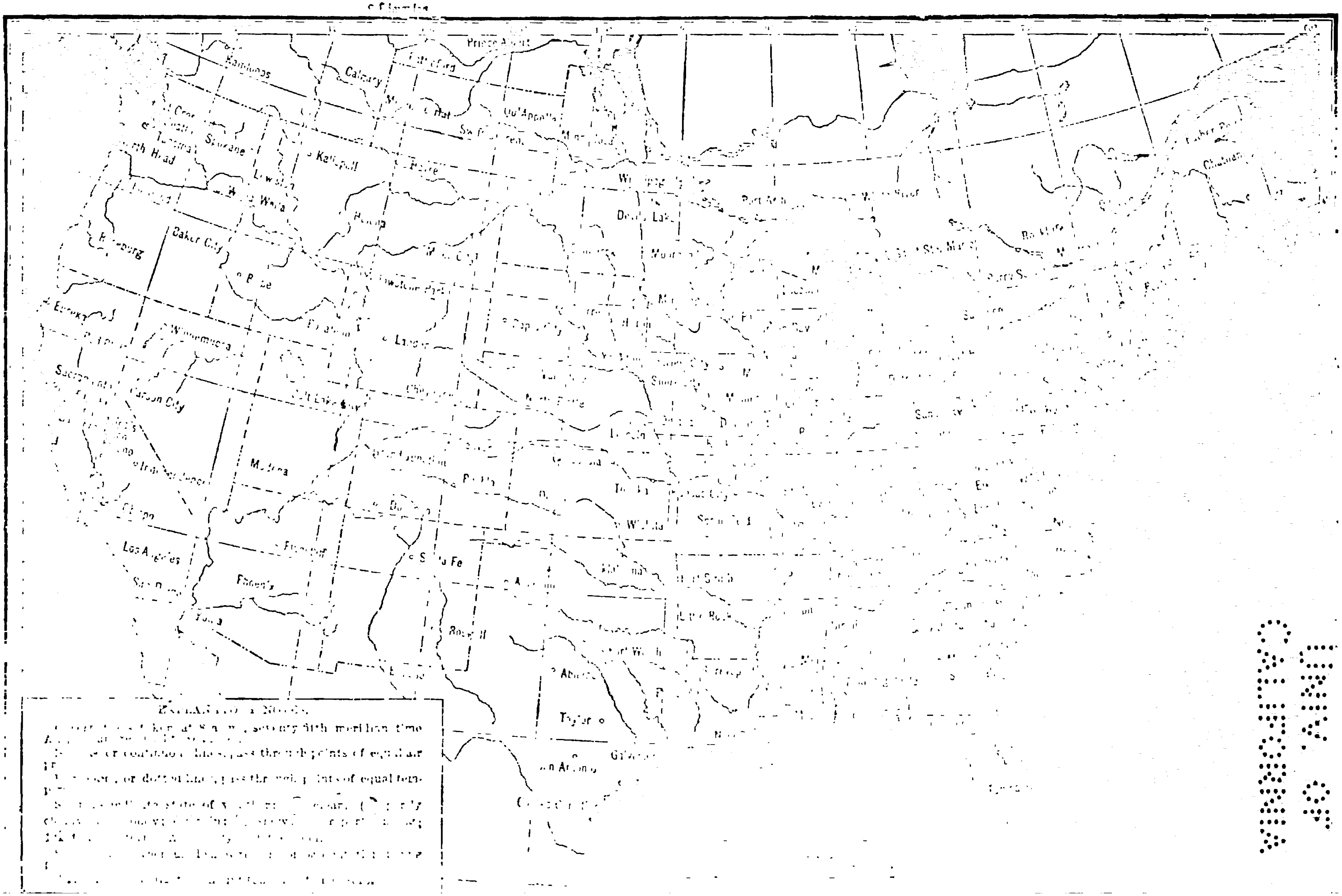

EXPLANATORY NOTES.

[illegible] seventy-fifth meridian time [illegible]

[illegible] or continuous lines, pass through points of equal air pressure.

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[illegible]

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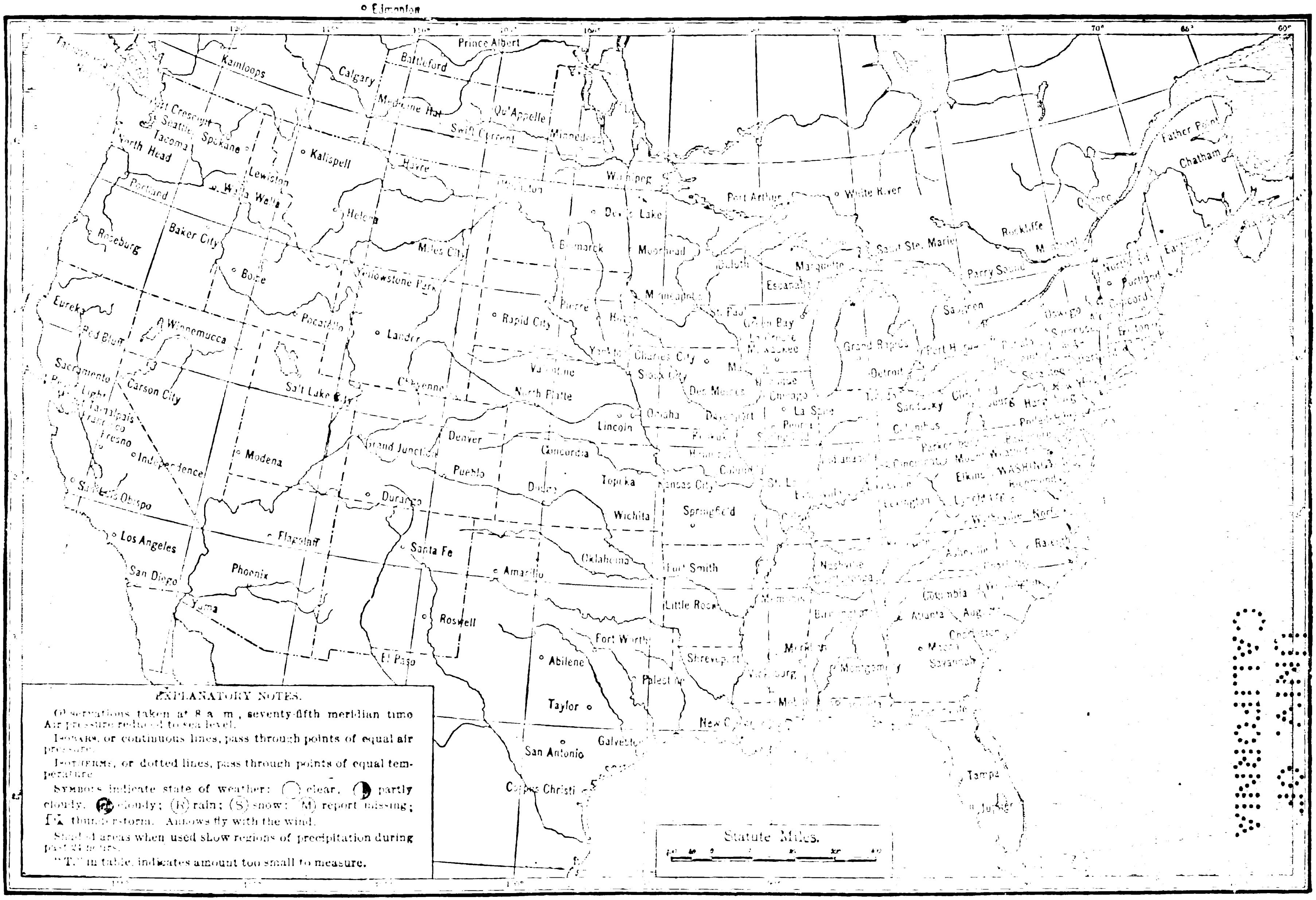

EXPLANATORY NOTES.

Observations taken at 8 a. m., seventy-fifth meridian time. Air pressure reduced to sea level.

ISOBARS, or continuous lines, pass through points of equal air pressure.

ISOTHERMS, or dotted lines, pass through points of equal temperature.

SYMBOLS indicate state of weather: ○ clear; ◑ partly cloudy; ● cloudy; Ⓡ rain; Ⓢ snow; Ⓜ report missing; ⛈ thunderstorm. Arrows fly with the wind.

Shaded areas when used show regions of precipitation during past 24 hours.

"T." in table, indicates amount too small to measure.

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